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UNIVERSIDADE DO PORTO

Risk factors for non-communicable diseases in Mozambique

Patrícia Padrão

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Dissertação de candidatura ao grau de Doutor apresentada à
Faculdade de Ciências da Nutrição e Alimentação
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II. Padrão P, Damasceno A, Silva-Matos C, Laszczyńska O, Prista A, Gouveia L, Lunet N. Low fruit and vegetable consumption in Mozambique: results from a national STEPS survey. Br J Nutr 2012; 107(3): 428-35.

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Colaborei na definição dos objetivos e na análise e interpretação dos dados de todos os artigos. Participei na codificação dos dados da ingestão alimentar do artigo VII e na recolha e armazenamento das amostras de pão do artigo VIII.
Fui responsável pela redação da versão inicial dos manuscritos I a VI e VIII e participei ativamente na elaboração das versões finais de todos os artigos.

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1. ABSTRACT

Non-communicable diseases (NCD) are the main cause of mortality worldwide, having accounted for two thirds of all deaths in 2010. In Mozambique, although communicable diseases are the most important contributors for the morbidity and mortality burden, NCD are becoming more frequent, being estimated to have accounted for one fifth of all deaths in 2010.

Worldwide, the most common NCD – cardiovascular (CV) diseases, cancer, chronic respiratory diseases and diabetes – share four main lifestyle risk factors (harmful use of alcohol, unhealthy diet, tobacco use, and insufficient physical activity), and frequent metabolic/physiologic changes (high blood pressure, high fasting blood glucose, high blood lipids, and overweight/obesity). Surveillance is essential to identify the population groups at higher risk, in different settings and over time, in order to develop policies for NCD prevention and control, although evidence from countries undergoing epidemiological transition is scarce.

This thesis aimed to characterize the exposure to excessive alcohol consumption, low fruit and vegetables intake, tobacco use, and insufficient physical activity, in the adult Mozambican population (papers I-IV), and to assess the clustering of the latter lifestyles and metabolic/physiologic risk factors, using *a priori* (paper V) and *a posteriori* (paper VI) approaches. We also aimed to obtain preliminary exploratory data on dietary intake and culinary practices in Maputo city (paper VII) and to quantify the sodium content of bread sold in the same region (paper VIII).

The studies I to VI were based on a national representative sample of Mozambican adults (n=3323) evaluated in 2005, following the World Health Organization (WHO) *Stepwise Approach to Chronic Disease Risk Factor Surveillance* (STEPS). Study VII evaluated a convenience sample of the adult general population from Maputo city (n=50) in 2012/2013, and study VIII included samples of white wheat fresh breads collected in June 2012 from 25 points of sale (all bakeries from Maputo listed in the Mozambican yellow pages, as well as the major traditional markets in the same geographical area).

In papers I to IV we described the distribution of the exposure to alcohol consumption, fruit and vegetables intake, tobacco use, and physical activity in adult Mozambicans. Almost one third of women and two thirds of men in Mozambique were current drinkers, from which nearly 40% reported to have had at least one binge drinking occasion in the previous week. The proportion of current drinkers reporting an usual daily consumption of alcoholic beverages in the previous year above the cut-offs of one standard drink for women and two for men, was 25.9% and 18.7%, respectively. The prevalence of current drinking increased with age and

education among women and with income among men. Less than 5% of the Mozambican adults reported a daily consumption of at least five servings of fruit and vegetables. The consumption of fruit and vegetables was more frequent in rural areas; in urban areas, fruit intake was more common among the more educated dwellers but vegetables consumption prevailed among the less educated men. Regarding tobacco use, almost one fifth of women and two fifths of men were current tobacco consumers, with manufactured cigarette smoking coexisting with traditional forms of tobacco use. Both manufactured and hand-rolled cigarette smoking were more prevalent among men while the use of smokeless tobacco was more frequent in women. Smoking hand-rolled cigarettes, snuffing and chewing tobacco prevailed in rural areas and tended to be more frequent among older and less educated dwellers, whereas manufactured cigarette smoking was more common among young less educated men, especially from urban areas, and also among the older and the more educated urban women. Less than 4% of adult Mozambicans did not meet the WHO physical activity recommendations; work-related activities, followed by transport, were the largest contributors to the high levels of physical activity. The time spent in vigorous activities was significantly higher in rural areas and decreased with education in all settings.

In papers V and VI, the clustering patterns of lifestyle and metabolic/physiologic CV risk factors showed that approximately 3% of the Mozambicans aged 40-64 years, were classified as having CV risk ≥20%, according to the WHO/International Society of Hypertension prediction charts, whereas using *a posteriori* approach, three clusters of CV risk were identified among women: 1) "healthier" (53.0%), with lower frequency of most risk factors; 2) "hypertension-overweight" (21.1%), more frequent in urban areas and older women; 3) "hypertension-smoking-alcohol" (25.9%), whose frequency increased with age and decreased with education. In men, two clusters were identified: 1) "hypertension-overweight" (30.1%); 2) "smoking" (69.9%). The frequency of the latter pattern was higher in urban areas and increased with age and education.

Regarding dietary intake (papers VII and VIII), unprocessed/minimally processed foods, particularly of vegetable origin, were the most frequently consumed foods in our sample of Maputo city inhabitants, alongside with a high consumption of some ultra-processed food products and processed ingredients, such as sugar sweetened beverages and chicken powdered stocks, reflecting the transition from traditional to contemporary patterns of eating. On the other hand, mean sodium content of the samples of bread collected from the most important selling points in Maputo city was 450 mg/100 g (range: 254.9 to 638.3 mg/100g). Although there are no manufacturer sodium targets for bread in Mozambique, most samples

(88%) were above the maximum levels recommended in the neighbouring South Africa (380 mg/100g).

The results from this thesis show the gradual acquisition of western lifestyles by the adult Mozambicans, supporting the need for monitoring these exposures and their health impact at a population level. However, the coexistence of traditional patterns of exposure to lifestyle factors should be taken into account when defining policies to control NCD risk factors. A combination of interventions targeting the whole population and individuals at high risk, including those with multiple risk factors as depicted in both clustering approaches, will be crucial to anticipate the expected undesirable shifts towards a more westernized way of life. However, NCD risk factors cannot be dissociated from the remaining social and health profile of the Mozambican population; meeting basic needs such as housing, safe water and sanitation, employment, access to education and to health care should be a priority.

The main conclusions of this thesis are the following:

- Excessive alcohol consumption, tobacco use and low fruit and vegetables intake are frequent risk factors in the adult Mozambican population, while insufficient physical activity is very uncommon.
- In Mozambique, western lifestyle behaviors coexist with traditional practices, reflected by the use of manufactured cigarettes (despite the very low number of cigarettes daily smoked), and processed food products, such as sugar sweetened beverages and chicken powdered stocks, concomitantly with the use of hand-rolled cigarettes and smokeless tobacco, the consumption of traditional dishes and patterns of drinking and sharing alcoholic beverages, and the high levels of work and transport physical activity.
- The analysis of sex-, age-, and region-specific data suggests a socio-demographic gradient of the transition of NCD risk factors: urban areas take the forward position and, generally, male and younger dwellers tend to move ahead of female and older subjects.
- Hypertension, overweight/obesity, smoking and excessive alcohol intake defined the main clusters of cardiovascular risk factors. These results suggests the need to implement an integrated approach addressing multiple risk factors, in order to control the expected shift towards a more westernized lifestyle in Mozambique.

2. RESUMO

As doenças não transmissíveis são a causa de morte mais frequente no mundo, tendo sido responsáveis por dois terços dos óbitos em 2010. Em Moçambique, apesar das doenças transmissíveis serem responsáveis pela maior carga de morbilidade e mortalidade, as doenças não transmissíveis estão a tornar-se mais frequentes, estimando-se que tenham sido responsáveis por um quinto de todas as mortes em 2010.

Globalmente, as doenças não transmissíveis mais comuns – doenças cardiovasculares, cancro, doenças respiratórias crónicas e diabetes – partilham quatro fatores de risco principais, relacionados com o estilo de vida (consumo excessivo de bebidas alcoólicas, alimentação desadequada, uso de tabaco e atividade física insuficiente) e alterações metabólicas/fisiológicas frequentes (pressão arterial elevada, glicemia em jejum elevada, hiperlipidemia e excesso de peso/obesidade). A monitorização é essencial para identificar os grupos populacionais em risco ao longo do tempo, de forma a desenvolver políticas para prevenção e controlo de doenças não transmissíveis, embora seja escassa a evidência proveniente de contextos em transição epidemiológica.

Esta tese pretendeu caracterizar a exposição ao consumo excessivo de bebidas alcoólicas, baixa ingestão de fruta e hortícolas, uso de tabaco e atividade física insuficiente, na população Moçambicana adulta (artigos I-IV) e avaliar a agregação desses fatores de risco e fatores de risco metabólicos/fisiológicos, usando abordagens *a priori* (artigo V) e *a posteriori* (artigo VI). Pretendemos também obter dados exploratórios preliminares de ingestão alimentar e práticas culinárias na cidade de Maputo (artigo VII) e quantificar o conteúdo de sódio no pão vendido na mesma área (artigo VIII).

Os estudos I a VI incluíram uma amostra nacional representativa de adultos Moçambicanos (n=3323) avaliados em 2005, segundo a metodologia da Organização Mundial da Saúde *Stepwise Approach to Chronic Disease Risk Factor Surveillance* (STEPS). O estudo VII avaliou, em 2012/2013, uma amostra de conveniência da população geral adulta da cidade de Maputo (n=50) e o estudo VIII incluiu amostras de pão “branco” fresco, de trigo, recolhidas em junho de 2012, em 25 pontos de venda alvo (todas as padarias da cidade de Maputo listadas nas páginas amarelas Moçambicanas, assim como os principais mercados tradicionais na mesma área geográfica).

Nos artigos I a IV descrevemos a distribuição da exposição ao consumo de bebidas alcoólicas, ingestão de fruta e hortícolas, uso de tabaco e atividade física em adultos Moçambicanos. Quase um terço das mulheres e dois terços dos homens eram bebedores atuais, dos quais 40% reportaram ter tido pelo menos um episódio de ingestão compulsiva de

bebidas alcoólicas na semana anterior. A proporção de bebedores que reportaram um consumo diário de bebidas alcoólicas no ano anterior, acima dos pontos de corte de uma bebida padrão para mulheres e duas para homens, foi de 25.9% e 18.7%, respetivamente. A prevalência de bebedores aumentou com a idade e com a escolaridade nas mulheres e com o rendimento nos homens. Menos de 5% dos adultos Moçambicanos reportaram uma ingestão diária de pelo menos cinco porções de fruta e hortícolas. O consumo de fruta e hortícolas foi mais frequente nas zonas rurais; nas zonas urbanas a ingestão de fruta foi mais comum nos indivíduos mais escolarizados mas o consumo de hortícolas prevaleceu nos homens menos escolarizados. Relativamente ao uso de tabaco, quase um quinto das mulheres e dois quintos dos homens eram consumidores atuais de tabaco, coexistindo o consumo de cigarros manufaturados com formas tradicionais de uso de tabaco. O consumo tanto dos cigarros manufaturados como dos enrolados manualmente foi mais prevalente nos homens enquanto o uso de tabaco sem fumo foi mais frequente nas mulheres. Fumar cigarros enrolados manualmente, inalar e mascar tabaco prevaleceram nas zonas rurais e tenderam a ser mais frequentes nos indivíduos mais velhos e menos escolarizados, enquanto o consumo de cigarros manufaturados foi mais comum nos homens mais novos e menos escolarizados, especialmente das zonas urbanas, e também nas mulheres urbanas mais velhas e mais escolarizadas. Menos de 4% dos adultos Moçambicanos não cumpriam o mínimo de atividade física estabelecido pela Organização Mundial da Saúde; a atividade física no trabalho, seguida da de transporte, foram as que mais contribuíram para os elevados níveis de atividade. O tempo despendido em atividades vigorosas foi significativamente superior nas zonas rurais e diminuiu com a escolaridade em todos os contextos.

Nos artigos V e VI, os padrões de agregação de fatores de risco do estilo de vida e metabólicos/fisiológicos, mostraram que aproximadamente 3% dos Moçambicanos com idades compreendidas entre 40 e 64 anos eram classificados como tendo um risco cardiovascular ≥20%, de acordo com os gráficos de predição da Organização Mundial da Saúde/Sociedade Internacional de Hipertensão, enquanto usando uma abordagem *a posteriori,* foram identificados três padrões nas mulheres: 1) “mais saudável” (53.0%), com frequência mais baixa da maioria dos fatores de risco; 2) “hipertensão-excesso de peso” (21.1%), mais frequente nas zonas urbanas e nas mulheres mais velhas; 3) “hipertensão-tabaco-álcool” (25.9%), cuja frequência aumentou com a idade e diminuiu com a escolaridade. Nos homens, foram identificados dois padrões: 1) “hipertensão-excesso de peso” (30.1%); 2) “tabaco” (69.9%). A frequência do último padrão foi mais elevada nas zonas urbanas e aumentou com a idade e a escolaridade.

Relativamente à ingestão alimentar (artigos VII e VIII), os alimentos não processados/minimamente processados, particularmente os de origem vegetal, foram os mais frequentemente consumidos na nossa amostra de habitantes da cidade de Maputo, paralelamente a um consumo elevado de alguns bens alimentares ultra-processados e ingredientes processados, como as bebidas açucaradas e os caldos de galinha em pó, refletindo a transição da alimentação tradicional para padrões alimentares contemporâneos. Por outro lado, o conteúdo médio de sódio das amostras de pão recolhidas nos pontos de venda de pão mais importantes da cidade de Maputo, foi de 450 mg/100 g (amplitude: 254.9 até 638.3 mg/100 g). Apesar de não existirem metas para o conteúdo de sódio para os fabricantes de pão em Moçambique, a maioria das amostras (88%) situou-se acima dos valores máximos recomendados na vizinha África do Sul (380 mg/100 g).

Os resultados desta tese mostram a aquisição gradual de estilos de vida ocidentais pela população moçambicana adulta, suportando a necessidade de monitorização destas exposições e do seu impacto na saúde a nível populacional. No entanto, a coexistência de padrões tradicionais de exposição a fatores do estilo de vida, deve ser tida em conta quando se definem políticas para controlar os fatores de risco de doenças não transmissíveis. Uma combinação de intervenções direcionadas a toda a população e a indivíduos expostos a elevado risco, incluindo aqueles com múltiplos fatores como descrito no estudo dos padrões de agregação, em ambas as abordagens utilizadas, será crucial para antecipar as esperadas mudanças indesejáveis para um modo de vida mais ocidentalizado. No entanto, os fatores de risco para as doenças não transmissíveis não podem ser dissociadas do restante padrão social e de saúde da população Moçambicana; atingir as necessidades básicas como habitação, saneamento básico, acesso a água potável, emprego, acesso a educação e a cuidados de saúde, deve ser uma prioridade.

As principais conclusões desta tese são as seguintes:

- O consumo excessivo de bebidas alcoólicas, o uso de tabaco e o baixo consumo de frutas e hortícolas são fatores de risco frequentes na população adulta de Moçambique enquanto a atividade física insuficiente é um fator de risco muito raro.
- Em Moçambique, os comportamentos de estilo de vida ocidental coexistem com práticas tradicionais, refletido pelo uso de cigarros manufaturados (apesar do reduzido número de cigarros fumados por dia) e produtos alimentares processados, como

bebidas açucaradas e caldos de galinha em pó, concomitantemente com o uso de cigarros enrolados à mão e tabaco sem fumo, o consumo de pratos tradicionais e os padrões de consumo e partilha de bebidas alcoólicas, bem como os elevados níveis de atividade física de trabalho e de transporte.

- A análise dos dados, específica por sexo, idade e região, sugere um gradiente sociodemográfico da transição de fatores de risco para doenças não transmissíveis: as áreas urbanas tomam a posição dianteira e, em geral, os homens e os indivíduos mais jovens tendem a mover-se à frente de mulheres e das pessoas mais velhas.
- Hipertensão, excesso de peso/obesidade, uso de tabaco e consumo excessivo de bebidas alcoólicas definem os principais padrões de fatores de risco cardiovascular. Estes resultados sugerem a necessidade de implementar uma abordagem integrada, envolvendo múltiplos fatores de risco, a fim de controlar a esperada mudança para um estilo de vida mais ocidentalizado, em Moçambique.

3. Abbreviations

AFR, World Health Organization African Region.

AHA, American Heart Association.

AMR, World Health Organization Region of the Americas.

BP, Blood Pressure.

CV, Cardiovascular.

EMR, World Health Organization Eastern Mediterranean Region.

EUR, World Health Organization European Region.

FAO, Food and Agriculture Organization.

HIV/AIDS, Human Immunodeficiency Virus Infection/ Acquired Immunodeficiency.

ISH, International Society of Hypertension.

NCD, Non-communicable Diseases.

SEAR, World Health Organization South-East Asia Region.

SFA, Saturated Fatty Acids.

STEPS, STEPwise Approach to Chronic Disease Risk Factor Surveillance.

UN, United Nations.

US$, United States Dollar.

WCRF, World Cancer Research Fund.

WHO, World Health Organization.

WPR, World Health Organization Western Pacific Region.

4. BACKGROUND

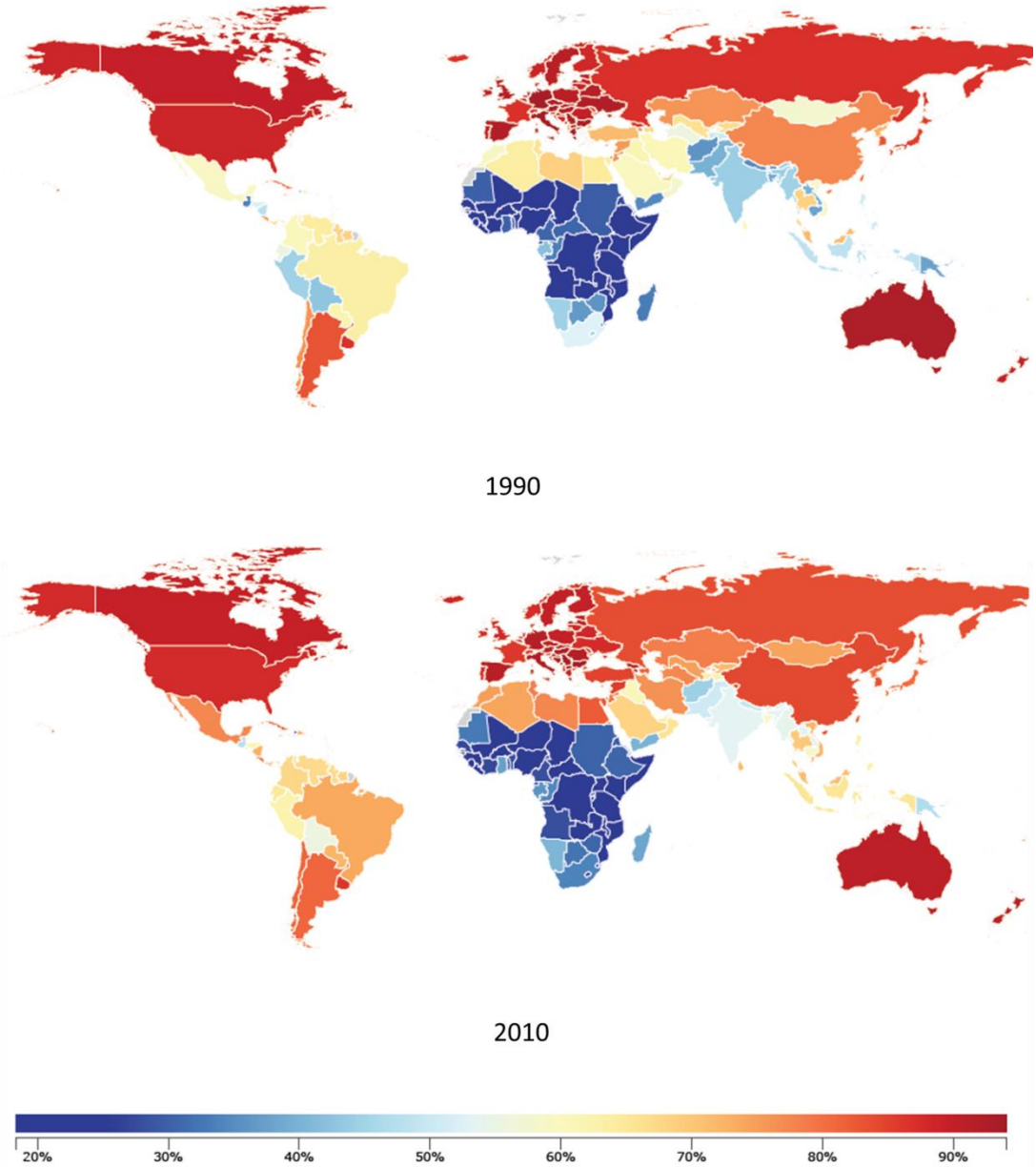
4.1. Burden of non-communicable diseases worldwide

Non-communicable diseases (NCD) are defined as medical conditions or diseases which are non-transmissible between persons, resulting from genetic and lifestyle factors. Usually they are chronic diseases, with long duration and with slow progression, although they may also be lethal in a short period of time [1, 2]. The World Health Organization (WHO) classifies NCD as “Group II Diseases”, while “Group I” includes communicable, maternal, perinatal and nutritional conditions, and “Group III” refers to unintentional and intentional injuries [3].

In the last decades there was a global shift towards NCD as the leading cause of death (Figure 1), which was driven by population ageing and lifestyles changes in a world increasingly more urbanized. Worldwide, the number of deaths due to NCD rose by almost 8 million since the 1990s, up to 34.5 million in 2010, corresponding to nearly two-thirds of the death toll [4]. In 2008, approximately 80% of all deaths due to NCD occurred in the lowest income nations (compared to 40% in 1990 [5]).

The number of deaths due to NCD is projected to reach 44 million deaths in 2020; the highest increase is expected in Africa, South-East Asia and the Eastern Mediterranean region, in contrast with no increase expected in the European Region [6]. In Africa, although there are still more deaths from infectious diseases, the burden of NCD is increasing rapidly and these are expected to become the most common causes of death in 2030 [6].

Figure 1. Percentage of deaths due to NCD in 1990 and 2010, by world region.



Source: Institute for Health Metrics and Evaluation, University of Washington, 2013 [7].

Worldwide, cardiovascular (CV) diseases, cancer, chronic respiratory diseases, and diabetes were the leading causes of deaths due to NCD in 2008, accounting for 48%, 21%, 12%, and 4% of all deaths from this group of diseases, respectively [6].

CV diseases

In 2010, CV diseases were responsible for 43% and 25% of all deaths in developed and developing countries, respectively [7], mostly due to ischemic heart disease, stroke, and diseases of the arteries. Congenital heart disease, rheumatic heart disease, cardiomyopathies or cardiac arrhythmias are much less frequent [8].

The absolute number of deaths from CV diseases increased 31% in the last two decades, and is expected to increase from 15.6 million in 2010 to 28 million by 2030. Ischemic heart disease (13.3%), followed by stroke (11.1%), accounted for the largest proportion of all deaths [4]. Hypertension is the largest single attributable risk factor to CV death, accounting for 51% and 45% of deaths due to stroke and ischemic heart disease in 2004, respectively [9].

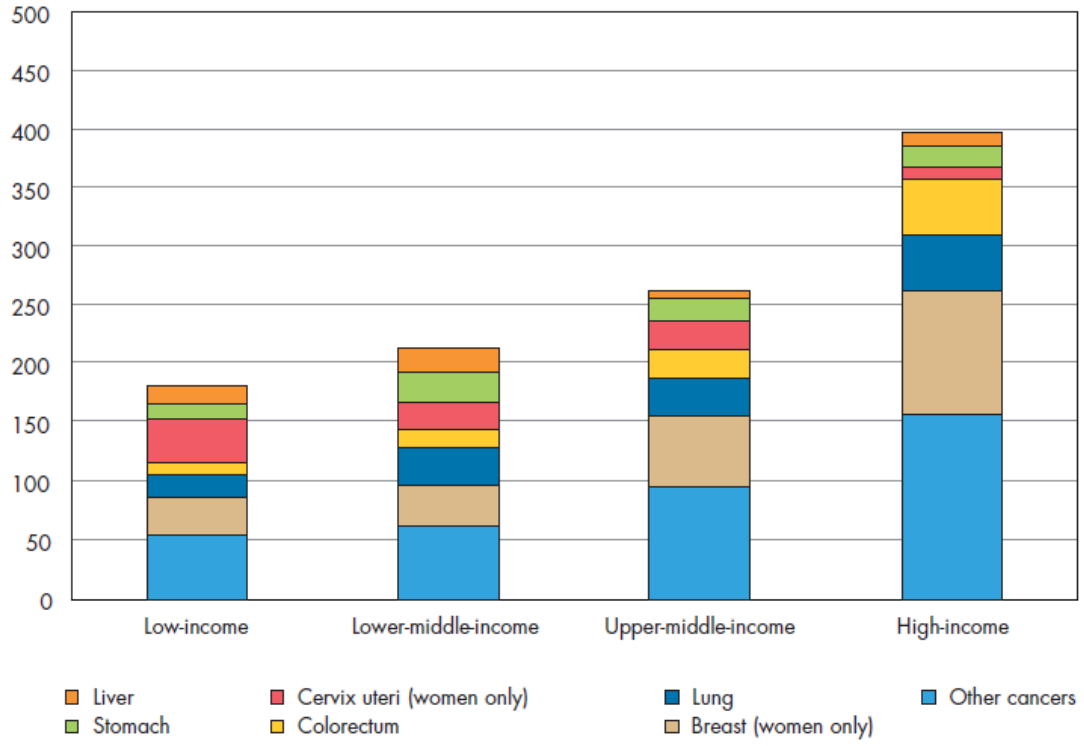
Cancer

Cancer was responsible for 8 million deaths worldwide (15.1% of all deaths) in 2010, 38% more than two decades before, and is expected to account for 13.1 million deaths in 2030. Lung, trachea and bronchus cancers were the most frequent cause of oncological death (1.5 million), twice the observed for the next three sites with higher mortality (liver, stomach and colon and rectum) [4].

Cancer morbidity and mortality is projected to increase in all regions of the world; the expected changes in population demographics are sufficient to predict an increase in cancer incidence from 12.7 million new cancer cases in 2008 to 21.4 million by 2030, with two-thirds occurring in low- and middle-income countries [6].

In 2008, the frequency of all cancers combined (excluding non-melanoma skin cancers), increased with the countries' level of economic development; the age-standardized incidence rates were more than twice higher in high-income than in the low-income settings [6]. Breast and colorectal cancer incidence increased with the level of country income, whereas cervical and liver cancer incidence was lower in high income countries compared to low- and middle-income countries (Figure 2). Prostate cancer incidence was approximately 10 times higher in high income than in lower-middle-income countries. Africa had the lowest reported incidence of colorectal, stomach, and lung cancer, but the highest incidence of cancer of the cervix uteri [6].

Figure 2. Age-standardize incidence rates of all cancers (excluding non-melanoma skin cancer), by type of cancer, per 100,000 population for both sexes, by World Bank income groups, 2008.



Source: World Health Organization, 2011 [6].

Chronic respiratory diseases

Chronic respiratory diseases were responsible for 3.8 million deaths in 2010, 5% less than in 1990 [4]. Worldwide, the more common diseases from this group are allergic rhinitis, asthma and chronic obstructive pulmonary disease, estimated to affect 400, 300 and 210 million of people, respectively [10].

The prevalence of asthma has increased in all countries in parallel with that of allergic rhinitis in the last four decades, with the trends towards urbanization and growing importance of modern lifestyles; it is estimated that there may be an additional 100 million people with asthma by 2025. Mortality seems to be high in countries where access to essential drugs is low, being estimated that asthma accounts for about 250 000 annual deaths worldwide [10].

Chronic obstructive pulmonary disease, although less prevalent than asthma and allergic rhinitis, was responsible for 76% of deaths due to chronic respiratory diseases worldwide in 2010. It is an important public health problem in subjects over 40 years, and is projected to increase over the next two decades, mainly in Asian and

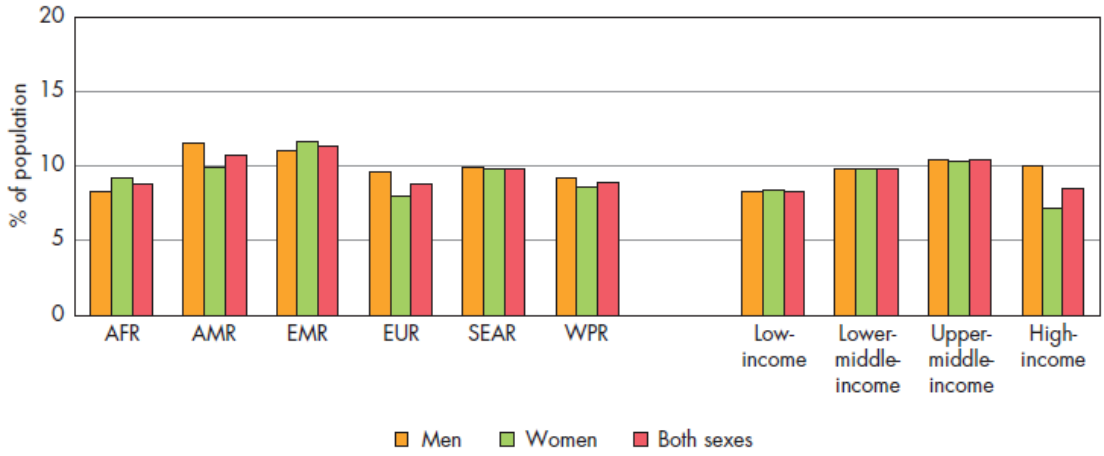
African countries, mostly as a result of a progressive increase in the prevalence of smoking [10].

Diabetes

Between 1990 and 2010, the number of deaths due to diabetes increased from 0.7 to 1.3 million [4]; more than 80% of those deaths occurred in low- and middle-income countries [11].

The global prevalence of diabetes in 2008 was estimated to be 10% in adults aged 25 or more years, being relatively consistent across countries with different levels of income, as depicted in figure 3 [6].

Figure 3. Age-standardized prevalence of diabetes in adults ≥25 years, by WHO regions and World Bank income group (2008).



Source: World Health Organization, 2011 [6].

People with diabetes have an increased risk of several diseases including CV diseases [6], nephropathy, neuropathy, retinopathy, and cancer [12], and require at least two to three times the amount of health-care resources compared to people who do not have diabetes. Also, the risk of tuberculosis is three times higher among people with diabetes [6].

The high burden of NCD involves important costs. Although research on the global effects of NCD is still in an early phase, their economic impact has been of concern, especially in developing countries where premature death is devastating. A joint report by the World Economic Forum and the Harvard School of Public Heath addressed the economic burden of

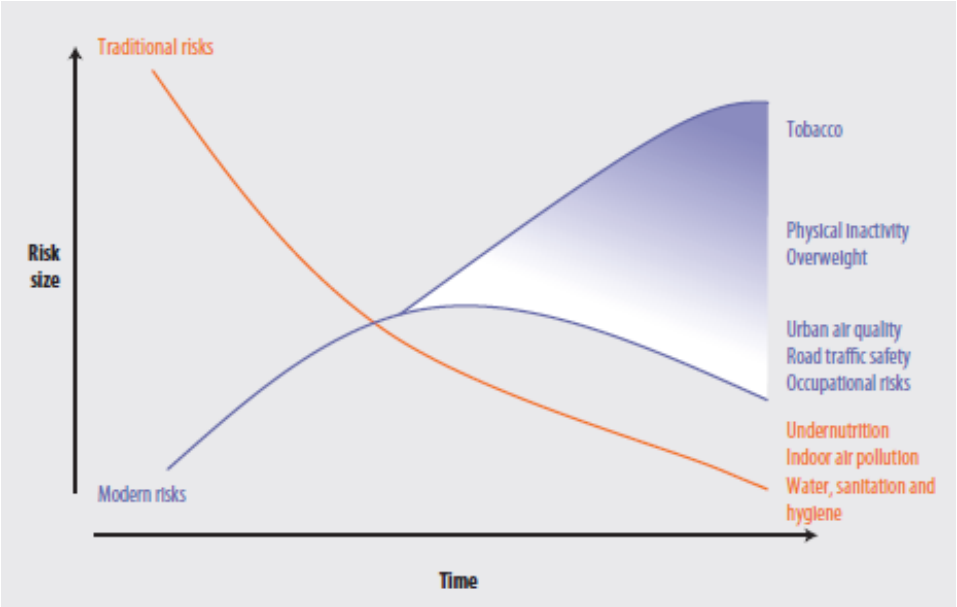
five NCD (CV diseases, cancer, chronic respiratory disease, diabetes, and mental illness). The key messages that emerged from the report suggest that those five NCD will be responsible for a loss of US$ 47 trillion over the next two decades; this loss represents 75% of global Gross Domestic Product in 2010 and also represents enough money to eradicate poverty among the 2.5 billion people who live with less than two US$/day for more than a century [13].

Given the rapid and global rise in the occurrence of NCD and their human and economic impact, the United Nations (UN) recognized the need to respond to this challenge of epidemic proportions and organized a High-level meeting on NCD in September 2011, the second which was dedicated to a health issue. A political declaration expressing the need of a whole-of-government and a whole-of-society effort, to reduce risk factors and create health-promoting environments, was assumed by all member states of the UN. All partners committed to strength of national policies and health systems, enhance international cooperation, and promote research and monitoring of the NCD burden [14].

4.2. Risk factors for non-communicable diseases

Worldwide, the exposure to the major risks that most affect the health is shifting from traditional (*e.g.* undernutrition or unsafe water and sanitation) to modern risks (*e.g.* physical inactivity or obesity), as depicted in Figure 4.

Figure 4. Transition of risks that most affect the health of the population worldwide.



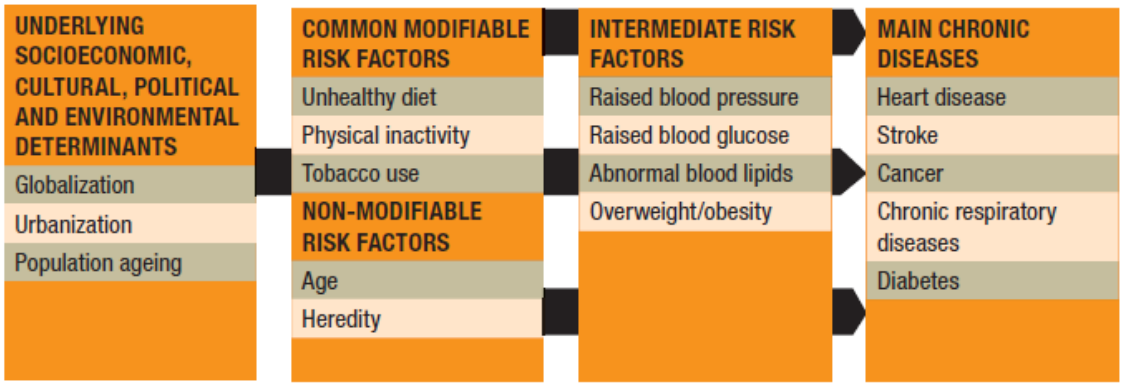
Source: World Health Organization, 2009 [9].

To illustrate this change, we may observe that in 1990 the three risk factors that most contributed to global disease burden expressed as a percentage of global disability-adjusted life-years, were childhood underweight, household air pollution from solid fuels, and tobacco smoking, while in 2010, it was high blood pressure (BP), tobacco smoking, and excessive alcohol consumption that mostly contributed to global disease burden [15].

According to the WHO, the risk factors for NCD may be outlined in three groups: (1) underlying socio-economic, cultural, political, and environmental determinants such as globalization, urbanization and population ageing; (2) modifiable risk factors, including tobacco use, physical inactivity, unhealthy diet, and harmful use of alcohol, as well as non-modifiable risk factors, including age and heredity; (3) metabolic/physiologic changes (intermediate risk factors), including high BP, high fasting blood glucose, high blood lipids, and

overweight/obesity. NCD such as heart disease, stroke, cancer, chronic respiratory diseases or diabetes will ultimately result from the exposure to these factors [6, 16] (Figure 5).

Figure 5. Risk factors for NCD.



Source: World Health Organization, 2005 [16].

Other factors, such as infections or dietary contaminants, particularly common in low income countries, may also fit the conceptual model presented. One of the most frequent examples are the risk factors for liver cancer whose mortality was partially attributed to hepatitis B infection (approximately half), and to hepatitis C (nearly one fourth) [4]. Among dietary contaminants aflotoxins are a prevalent problem in some regions namely in the sub Saharan Africa [17] and were estimated to have a causative role in 5–28% of all hepatocellular cancers [18].

4.2.1. Lifestyle risk factors

Much of the human, social and economic impact of the NCD-related deaths could be averted since they are caused, to a large extent, by behavioral risk factors [6]. Harmful use of alcohol, unhealthy diet, tobacco consumption, and insufficient physical activity are the four lifestyle risk factors that most contribute to the NCD burden.

Excessive alcohol consumption

The American Heart Association (AHA) and the World Cancer Research Fund (WCRF) recommend the maximum daily intake of 1 standard alcoholic drink for women and 2 for men [19, 20], although the WCRF emphasizes that for cancer prevention the best protection is achieved by not drinking alcohol at all [20].

The impact of alcohol consumption on disease and injury is associated with two dimensions of drinking, the volume of alcohol consumed and the pattern of drinking, being the presence of heavy drinking events one of the key characteristics of the drinking pattern [21].

Alcohol consumption was responsible for 4.9 million deaths worldwide in 2010, compared to 3.7 million in 1990 [15]. More than half of these deaths occurred as a result of NCD, including cancers, CV diseases and liver cirrhosis [6]. In 2010, alcohol use was responsible for 7.4% of the global burden of disease expressed as a percentage of disability-adjusted life-years among men being the third risk factor that most contributed to the disease burden, compared with 3.0% among women (eighth risk factor that most contributed to the disease burden) [4].

Excessive alcohol drinking increases the risk of injuries (intentional and unintentional) and diseases, namely neuropsychiatric disorders, tuberculosis, gastrointestinal diseases (particularly liver cirrhosis and pancreatitis), cancer (including breast, larynx, oral cavity, esophagus, stomach, colorectal, and liver), diabetes, and CV diseases [6, 15]. The association between alcohol consumption and ischemic heart and cerebrovascular diseases is complex. Some research data, mainly from high-income countries, suggest that low-risk alcohol consumption may have a beneficial effect on selected disease outcomes and in some populations groups [22-25], but these effects tend to disappear in heavy episodic drinking patterns [26, 27].

Although almost half of the global adult population has never consumed alcoholic beverages, in some cultures it is a very rooted habit. There is a high level of variation in alcohol consumption around the world; global adult per capita availability was estimated at 6.0 L of pure alcohol in 2008, being highest in the European Region (12.2 L) and lowest in the Eastern Mediterranean Region (0.6 L). The adult per capita availability in upper-middle- and high-income countries (around 10 L) was more than double the level of low- and lower-middle-income countries (about 3 to 4 L) [6]. However, a large portion of alcohol consumption (estimated in about 30% of total worldwide adult intake) is not recorded which difficult the estimation of the true consumption. Generally, with increasing income, alcohol use increases and the proportion of unrecorded alcohol consumption decreases. In addition, the consumption of homemade or illegally produced alcohol (frequent in African countries) may be associated with an increased risk of harm because of unknown and potentially dangerous components and contaminants in these beverages [21].

Unhealthy diet

Human diet is becoming more energy-dense; processed foods frequently high in fat, sugar and sodium tend to be more easily available with increasing urbanization and globalization. At the same time, the consumption of high fiber content foods such as legumes, other vegetables, and fruit are decreasing, and whole grains are shifting to refined grains and being replaced by processed products [28, 29] in contrast with the recommendations for the prevention of CV diseases and cancer [19, 20].

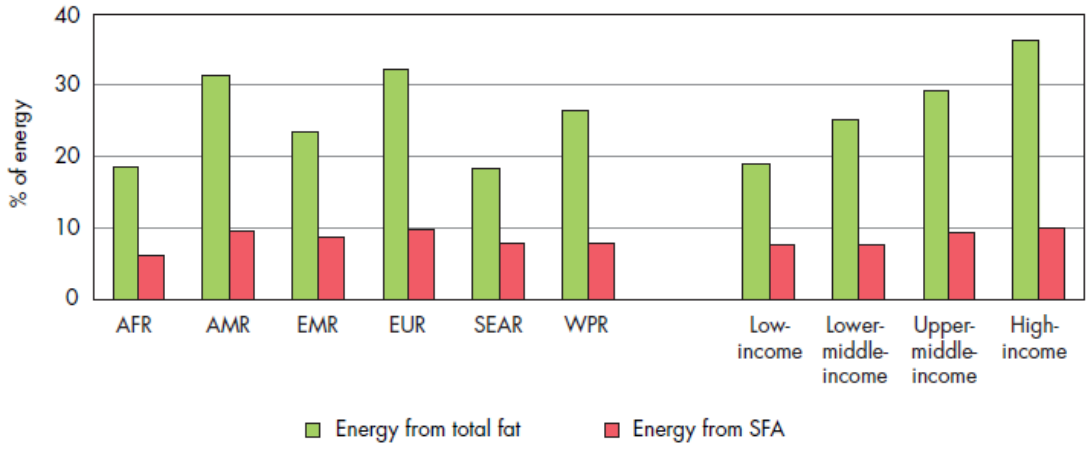
However, given the diversity of dietary patterns and the complexity of their composition and definitions, it is difficult to generate overall estimations of unhealthy diet prevalence. Estimates of the specific components of unhealthy diet are, therefore, more commonly addressed.

The joint FAO/WHO [30], the AHA [19], and the WCRF [20], recommend at least five daily servings of fruit and vegetables for the prevention of chronic diseases. Low fruit and vegetables intake was responsible for approximately 6.7 million deaths worldwide in 2010, compared to 5.1 million in 1990 [15]. Adequate consumption of fruit and vegetables reduces the risk for CV diseases, stomach and colorectal cancers [31-33]. Global data on consumption show that more than three-quarters of the population consume less than the minimum recommendation of five daily servings of fruit and vegetables [34].

High sodium intake was responsible for an estimated 3.1 million deaths worldwide in 2010, compared to 2.2 million in 1990 [15], and is strongly associated with high BP [35]. The WHO recommends no more than 2 g of sodium (5 g of salt) per day in adults, in order to reduce the burden of NCD [36]; however, in all countries with recent data available the salt intake is much higher than recommended [37]. It is estimated that decreasing dietary salt intake from the current global levels of 9–12 g per day – to the recommended level of 5 g per day – would have an important impact on reducing BP and CV diseases [38].

Saturated fat and trans-fat increase the risk of coronary heart disease, and the replacement of these two types of fat with monounsaturated and polyunsaturated fat has the opposite effect [39]. In addition, the risk of type 2 diabetes is directly associated with consumption of saturated fat and trans-fat and inversely associated with polyunsaturated fat from vegetable sources [40, 41]. Data derived from national *Food Balance Sheets* show large variations across world regions in the amount of total fats available for human consumption. As shown in Figure 6, the highest quantities were recorded in the European Region while the lowest were observed in the South-East Asia Region. For saturated fatty acids, African Region showed the lowest availabilities while the highest were recorded in the European Region and in the Americas, with very high values observed in some of the Pacific Islands. The availability of total fat increases with country income level, while the availability of saturated fat is about 8% of total energy supply in low- and lower-middle-income countries and 10% in upper middle- income and in high-income countries [6].

Figure 6. Availability of total fat and saturated fatty acids (SFA) (as % dietary energy supply) for 2005-7, by WHO Region and World Bank income group.



SFA, saturated fatty acids

Source: World Health Organization, 2011 [6].

The WCRF recommends to limit the intake of red meat and to avoid processed meat, which have been associated with an increased risk of colorectal cancer. Another recommendation for cancer prevention, is to restrict the consumption of energy dense foods, namely by avoiding added sugary drinks [20].

Tobacco use

Smoking is the most prevalent usage of tobacco and manufactured cigarettes represent the main form of smoking, despite traditional forms of smoked tobacco are also consumed, particularly in Asia, Africa and the Middle East. Although data on those forms of tobacco use are not easily available, it is estimated to be substantial [6].

Current smokers (approximately 1 billion) are estimated to consume about 6 trillion cigarettes annually, affecting not only their health but also that from those who are exposed to second-hand smoke [42].

In 2010, smoking and the exposure to second-hand smoke accounted for 12% of all deaths worldwide. From the 6.3 million deaths caused by tobacco (compared to 5.3 million in 1990), 5.7 million were due to direct tobacco use [4].

Smoking is estimated to cause about 71% of all lung cancer, 42% of chronic respiratory disease and nearly 10% of CV diseases [9]. In addition, it is also an important risk factor for tuberculosis and lower respiratory infections [43]. Worldwide, in 2010, tobacco smoking and exposure to second-hand smoke accounted for 8.4% of the burden of disease expressed as a percentage of global disability-adjusted life-years

among men (being the risk factor that most contributed to the disease burden) compared with 3.7% among women (the fourth risk factor that most contributed to the disease burden) [4].

In 2008, the highest overall prevalence of smoking was observed in the European Region (29%), and the lowest in the African Region (8%). Among men, smoking was more frequent in the Western Pacific Region (46%) while among women, it was in the European Region (20%). In all regions, men smoked more than women, with the largest disparities for daily cigarette smoking being in the Western Pacific Region (men smoked 15 times more than women), whereas the smallest disparity between sexes was observed in the Region of the Americas (men smoke about 1.5 times more than women) [6]. Regarding income groups, in men, the highest prevalence of smoking was found in lower-middle-income countries, while among women, relatively high frequencies were reported in upper-middle and high-income countries [6].

Although smoking is the most frequently form of tobacco use globally, smokeless tobacco is common in many populations, especially in Asia and Africa settings. Despite its health effects need to be better characterized [44], smokeless tobacco has been associated with oral cancer, hypertension, heart disease among other conditions [6].

Insufficient physical activity

The WHO recommendations on physical activity for adults include at least 150 minutes of moderate-intensity aerobic physical activity or at least 75 minutes of vigorous-intensity aerobic physical activity throughout the week, or an equivalent combination of moderate- and vigorous-intensity activity [45].

In 2010, approximately 3.2 million (6.1%) deaths were attributable to insufficient physical activity worldwide [15]. Insufficiently physically active people have a 20–30% increased risk of all-cause mortality compared to those who participate in at least 30 minutes of moderate intensity physical activity on most days of the week. Meeting the WHO recommendations on physical activity is estimated to reduce the risk of ischemic heart disease (by 30%), diabetes (by 27%), and breast and colon cancer (by 21–25%) [9, 45]. In addition, physical activity lowers the risk of stroke,

hypertension and depression, and contributes to energy balance and weight control [45].

Globally, in 2008, almost one third of subjects aged 15 years or older were insufficiently active (men 28% and women 34%); the highest prevalences of insufficient physical activity were observed in the WHO Region of the Americas and the Eastern Mediterranean Region (50% in women and 36-40% in men). On the other hand, the South-East Asia Region showed the lowest percentages (15% for men and 19% for women) [6].

In all WHO regions, men are more active than women, with the largest sex differences in prevalence being observed in the Eastern Mediterranean Region. High-income countries had more than twice the prevalence of insufficient physical activity (41% of men and 48% of women), compared to low-income countries (18% of men and 21% of women). The high work and transport physical activity among the latter contributes to explain these differences [6].

Although the main scope of this thesis is the exposure to lifestyle risk factors, we must briefly highlight the weight of metabolic/physiologic risk factors worldwide, before focusing in the Mozambican reality. In 2010, high BP was the risk factor responsible for the higher number of deaths globally, accounting for 9.4 million deaths; high body mass index and high fasting plasma glucose caused 3.4 million deaths, each, while high total cholesterol was responsible for 2.0 million deaths [15].

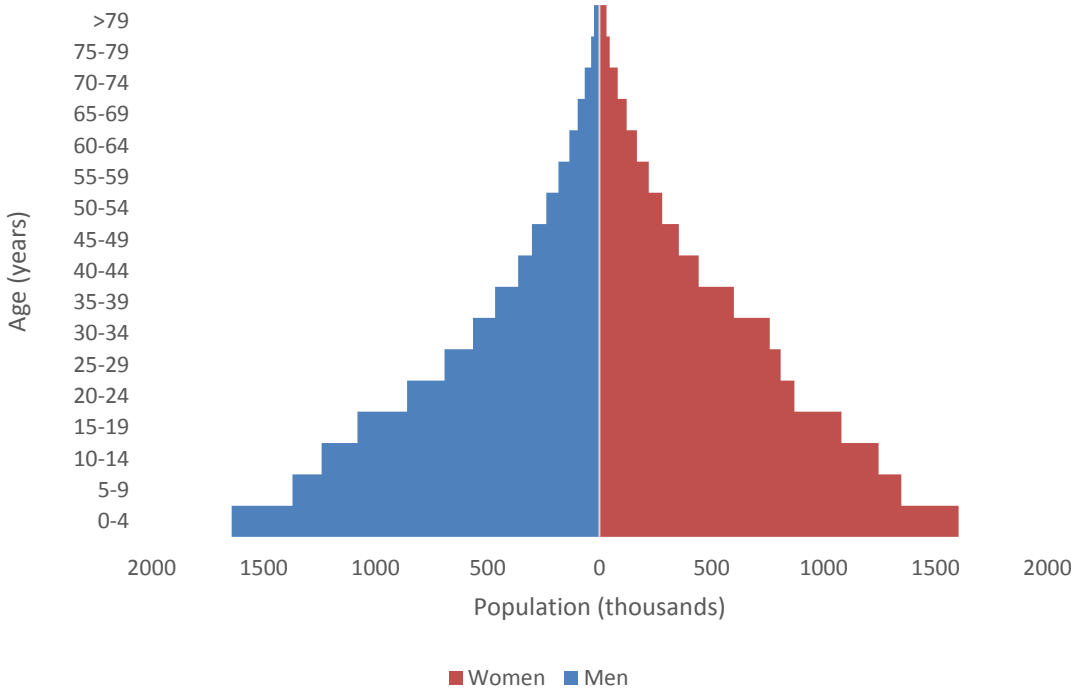
4.3. Non-communicable diseases in Mozambique

Mozambique is a low income sub-Saharan country located in the southeastern Africa. During the last four decades its population more than doubled, and is currently estimated to have about 23 million inhabitants, distributed by eleven provinces [46].

Following the independence from Portugal, in 1975, Mozambique underwent a civil war that lasted for almost two decades. The country became extremely impoverished being considered one of the poorest countries in the world. The transition to peace and political stability, culminated in the country's first democratic election in 1994. Since then, its economic growth has been impressive, exceeding 7% in 2012. Nevertheless, the economic growth has not been followed by the creation of jobs and livelihoods, neither to a massive reduction in poverty and food insecurity [47]; in 2012 Mozambique ranked 185th out of 186 places of the UN Human Development Index [48]. Data from the household surveys carried out by the Mozambican National Institute of Statistics [49] documented a 15% decrease in the proportion of the population living under poverty between 1996/97 and 2002/2003 (from 69.4% to 54.1%). Since then, the percentage of Mozambicans considered poor remained stable until 2008/09 (approximately 55% of the population, despite regional differences), although above the officially-stated goal of 45% by 2009. The very slow growth in agriculture productivity, weather shocks in 2008, particularly in the central provinces, and the large increases in international food and fuel prices, were the main drivers of poverty stagnation [50]. Poverty rates are higher in rural setting; approximately three out of four inhabitants living in rural areas are classified as poor [51].

As depicted in figure 7, the age-structure of the Mozambican population includes a large proportion of subjects aged below 15 years (44%) and only 5% over 59 years [52], reflecting the high fertility rate (above 5 children per woman) [53], the still high under-five mortality (141 deaths per 1,000 live births in 2008), and the high number of deaths due to HIV/AIDS and malaria [54, 55]. Nevertheless, with the implementation of preventive measures to reduce early childhood diseases and to prevent malaria, together with the increasing coverage of antiretroviral therapy [56], the life expectancy at birth has increased from 42 years in 1997 [54] to 52 years in 2011 [53].

Figure 7. Population pyramid from Mozambique, 2005.



Although school attendance has improved, especially at the primary level, the primary school dropout is observed in approximately two thirds of the population [48]. The prevalence of illiteracy among Mozambican adults ranges between 10% in Maputo city (the capital city, located in the South) and 67% in *Cabo Delgado* (located in the north of the country) [57].

Nearly 70% of the Mozambican population lives in rural areas, and almost all of the latter (96%) are engaged in agriculture. Despite employing close to 80% of the national workforce, the agriculture sector remains unproductive and subsistence-based; nevertheless, small-scale agriculture is an important source of income and a main contributor for the national agricultural production [51]. The weight of food for the budget of the Mozambicans is high; the last *Household Budget Survey* reported that 80% of the families spend more than 60% of their overall budget in food [49].

According to data from last census, more than two-thirds of the houses in Mozambique are straw-bale constructions ("*palhotas*") [54]. Just over two fifths (43%) of households have access to safe drinking water, most of them from a borehole or a water well, and almost a fifth (19%) have access to safe sanitation [55]. The WHO estimated that in 2008 a total of 16% of all deaths in Mozambique were attributed to inadequate water, sanitation and hygiene practices [58].

Chronic malnutrition in children under five remains very high due to a number of factors including poor diet, inadequate nutritional intake (energy, macro- and micronutrients),

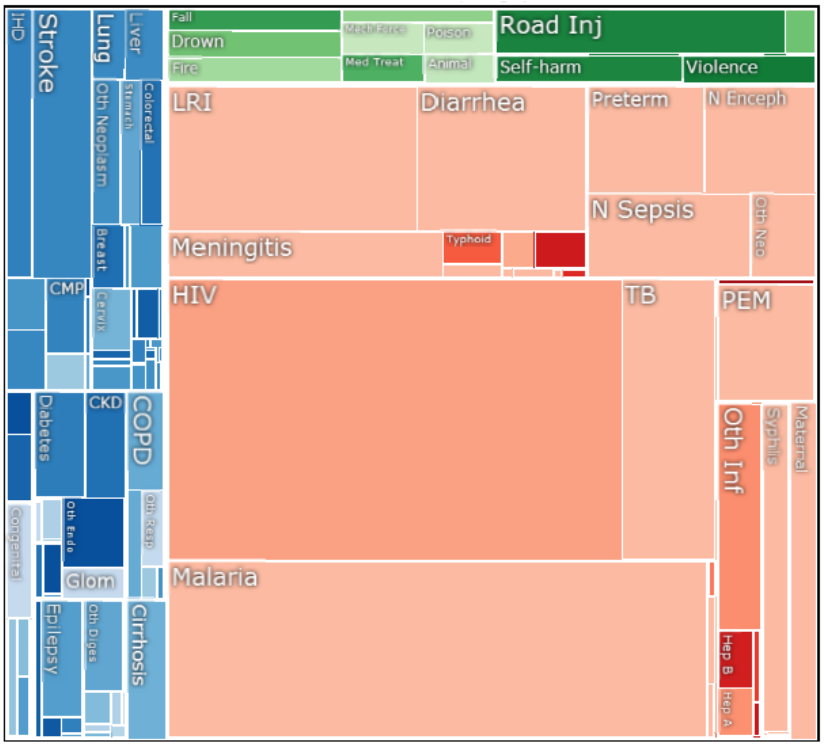
low prevalence of exclusive breastfeeding [59] (in 2008, 37% of children were exclusively breastfed until the first 6 months [55]), and high levels of infection [51]. In 2010/2012 the prevalence of children under-five whose food intake was insufficient to meet dietary energy requirements was estimated in 39% (12% less than in 1990/92) while the prevalence of stunting in 2008 was 44% (16% less than in 1995) [60]. Micronutrient deficiencies are also very common, affecting 74% (iron), 69% (vitamin A) and 65% (iodine) of under-five children [51]. In 2010, protein-energy malnutrition was the first cause of death in the first year of life [7].

Health care resources remain deficient; it is estimated that there are less than 5 physicians, and 30 nurses/midwifes per 100,000 inhabitants in Mozambique, which is approximately 4 times less than in the whole African region (20 and 110, respectively) [52]. Heavy workloads, closure of some services, deficient patient heath care access, inability to release staff for continuing education, conflicts with patients, and patients not properly treated, are some of the consequences of the lack of staff and poor conditions of work. Also, due to the lack of staff, health workers are compelled to assume a diversity of extra tasks beyond their traditional professional skills without being rewarded [61]. In addition to the scarce human resources, Mozambique is highly dependent on donor aid which covers about 70% of the health budget [62].

4.3.1. Disease burden and mortality profile in Mozambique

As in the other sub-Saharan countries, the burden of communicable diseases, together with maternal, perinatal and nutritional conditions prevails in Mozambique (Figure 8). HIV/AIDS and malaria were responsible for almost two fifths of the overall number of deaths in 2010 (22% and 17%, respectively) [7]; HIV/AIDS was the leading cause of death in urban areas, followed by malaria, while the inverse occurred in rural areas [63].

Figure 8. Distribution of the different causes of death (both sexes, all ages) in Mozambique, in 2010.



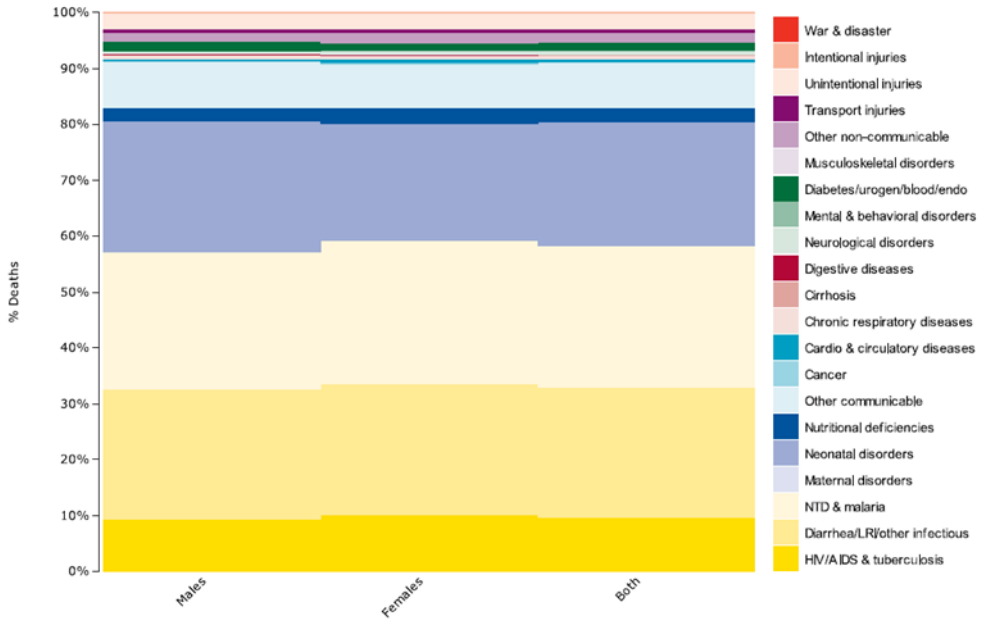
Pink – communicable diseases, maternal, perinatal and nutritional conditions
Blue – NCD
Green – unintentional and intentional injuries

Source: Institute for Health Metrics and Evaluation, University of Washington, 2013 [7].

During 2007, just over two fifths (43%) of the Mozambicans died before reaching the age of five years while less than one fifth of deaths were after 50 years of age. The causes of death show wide variation with age as depicted in figures 9 to 13.

In 2010 the main causes of mortality under-five years were malaria (25.0%), diarrheal/lower respiratory infections/other infectious diseases (23.0%), neonatal disorders (22.0%), and HIV/AIDS and tuberculosis (9.6%) (Figure 9) [7].

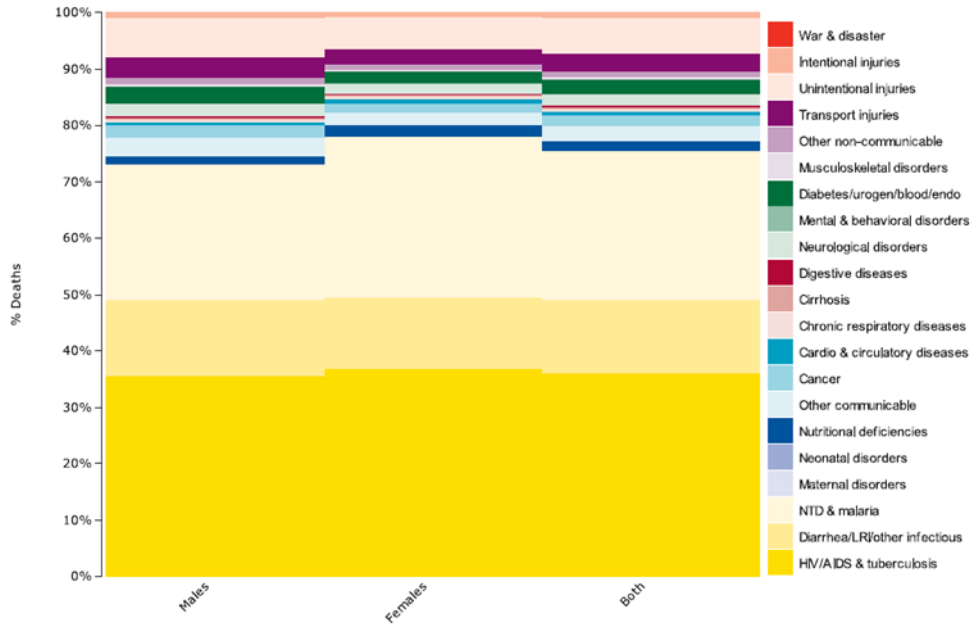
Figure 9. Distribution of the different causes of death among Mozambicans aged under-five years, in 2010.



Source: Institute for Health Metrics and Evaluation, University of Washington, 2013 [7].

In the age group 5-14 years, HIV/AIDS and tuberculosis prevailed as causes of death (36.0%); followed by malaria (26.0%); and diarrheal/lower respiratory infections/other infectious diseases (13.0%) [7] (Figure 10).

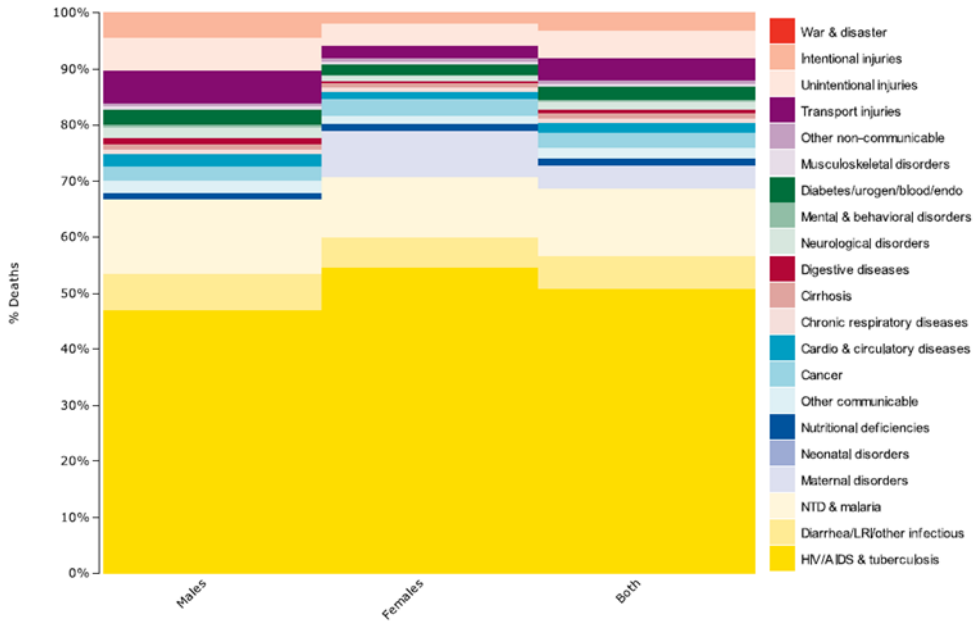
Figure 10. Distribution of the different causes of death among Mozambicans aged 5-14 years, in 2010.



Source: Institute for Health Metrics and Evaluation, University of Washington, 2013 [7].

Figure 11 shows that HIV/AIDS and tuberculosis were the main causes of death among Mozambicans aged 15-49 years, having caused approximately half the deaths in 2010, followed by malaria (12.0%) [7].

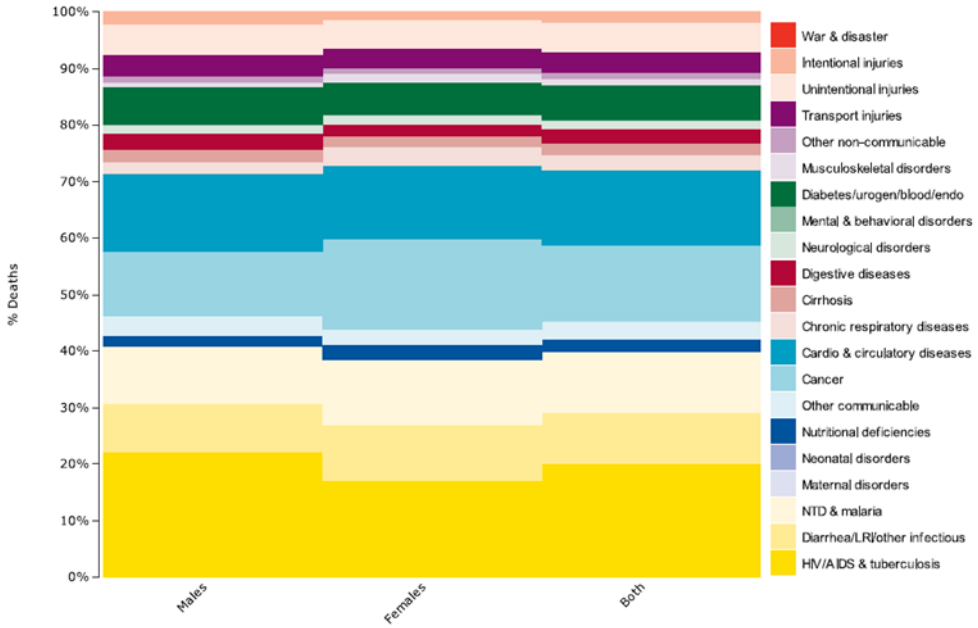
Figure 11. Distribution of the different causes of death among Mozambicans aged 15-49 years, in 2010.



Source: Institute for Health Metrics and Evaluation, University of Washington, 2013 [7].

Although HIV/AIDS and tuberculosis were still the first cause of death between 50 and 69 years, having caused one fifth of deaths in this age group, CV diseases and cancer were already responsible for a sizable burden; each of these groups accounted for 13.0% of all deaths in 2010 (Figure 12).

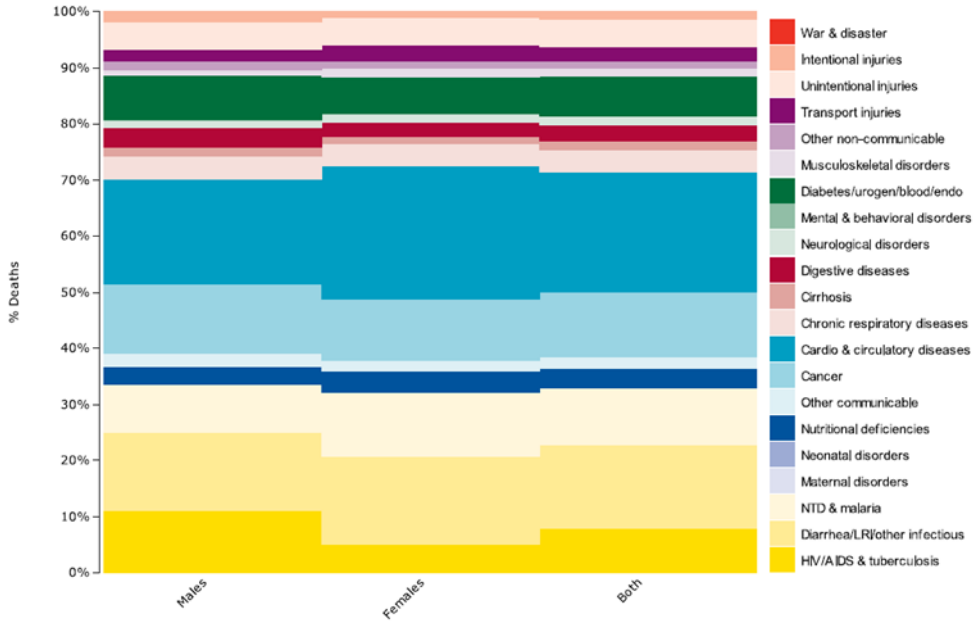
Figure 12. Distribution of the different causes of death among Mozambicans aged 50-69 years, in 2010.



Source: Institute for Health Metrics and Evaluation, University of Washington, 2013 [7].

In the oldest group (>69 years) the weight of CV diseases is much more important (21.0% of total deaths), followed by HIV/AIDS and tuberculosis (15.0%) and cancer (12.0%) (Figure 13) [7].

Figure 13. Distribution of the different causes of death among Mozambicans aged >69 years, in 2010.



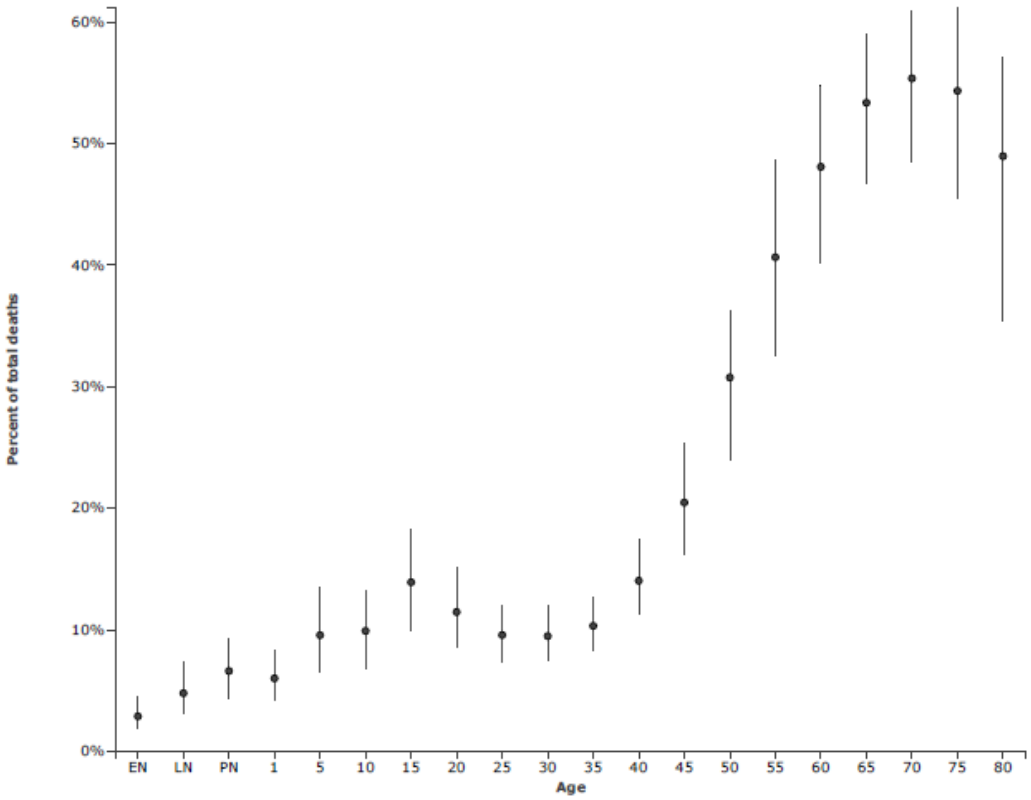
Source: Institute for Health Metrics and Evaluation, University of Washington, 2013 [7].

The importance of HIV/AIDS as cause of death in different age groups, with a devastating impact in Mozambique, reflects the high prevalence of HIV infection and the still low coverage of antiretroviral therapy [56]. The percentage of Mozambicans aged 15-49 years infected with HIV is estimated to be 11.4%. The epidemic affects predominantly the most productive segment of the population, reaching 22.9% of the inhabitants aged 30-34 years [64]. It is estimated that 61.0% of HIV positive patients are also co-infected with tuberculosis [65]. Mozambique ranks 16th among countries with the highest tuberculosis burden affecting more than one fifth of the population [66] and having caused 4.5% of deaths in 2010 [7].

Malaria is also one of the most important causes of death in Mozambique, particularly among the younger dwellers. In 2002/2003 it has been estimated that 58.9% of the Mozambican children under 10 years were positive for infection with *Plasmodium sp.*, although less than 7% were symptomatic [67]. This mosquito-borne disease is the most frequent cause of admission and outpatient consultation in health units, being responsible of approximately 60% of the pediatric hospital admissions. Malaria is also the major cause of hospital mortality in Mozambique, accounting for nearly one fourth of all deaths [68]. In 2007/2008, the proportion of deaths due to malaria was higher in the northern provinces (more than 30% of all deaths) and lower in Maputo City and Province (less than 15% of all deaths) [63].

Although communicable diseases are responsible for the largest burden of disease and the highest number of deaths, NCD are becoming more frequent, being estimated to have accounted for 19.9% of all deaths in 2010. Figure 14 illustrates the increasing frequency of NCD with age in the Mozambican population. CV diseases were responsible for 5.6% of the deaths, cancer for 4.7%, chronic respiratory diseases for 1.4%, and diabetes for 0.9% [7].

Figure 14. Percent of total deaths due to NCD by age group, in Mozambique, in 2010.



Source: Institute for Health Metrics and Evaluation, University of Washington, 2013 [7].

The relevance of CV diseases as leading cause of death among older Mozambicans was clearly depicted in Figures 12 and 13. In 1994 cerebrovascular diseases were already the leading cause of death among Maputo inhabitants aged over 60 years [69] and remained among the most frequent in 2010, having caused just over one tenth of the deaths in Mozambicans older than 69 years. Between 2005 and 2006 the incidence of stroke hospitalization in Maputo was estimated to be 148.7 per 100,000, one of the highest in developing settings [70], and the early case-fatality rates were also high [71].

Regarding oncological diseases, information from a cancer registry of *Lourenço Marques* (Maputo) obtained a long time ago, between 1956 and 1960, identified 600 cases, and showed that liver cancer was the most frequent cancer in both sexes (65.5% and 31.0% of cases in men and women respectively), followed by cancers of the bladder (6.0% of cases) and non-Hodgkin lymphomas (4.5% of cases) among men, and by cancers of the cervix (21.3% of cases) and bladder (10.7% of cases), among women [72]. Data taken from the Maputo City death registry and autopsy records for 1994, showed that liver cancer and cervix cancer, were the most frequent causes of cancer death among men and women, respectively [69]. In a cancer registry recently set up in the second largest city (*Beira)* from a different province of Mozambique (*Sofala*), Kaposi sarcoma and non-Hodgkin lymphoma, were the most frequent cancers among men, while cervix cancer, followed by Kaposi sarcoma prevailed among women. In the same registry, breast cancer was the third cause of cancer in women [73]. Between 2000 and 2010 there was an increasing trend in the number of incident cases of cancer, all cancers in general and Kaposi sarcoma in particular, in *Beira* and in Maputo [74]. National data from verbal autopsies, recorded in 2007, showed that infection-related cancers contributed to a large proportion of cancers [63].

Chronic obstructive pulmonary disease was the main contributor for mortality from chronic respiratory diseases, in Mozambique. It was responsible for 0.7% of total deaths with higher weight among dwellers above 60 years [7]. Asthma caused 0.3% of all deaths in 2010 and is also considered an important public health problem; in 2004 the prevalence of asthma was estimated to be 13.3% among children and adolescents from Maputo city [75], and it was the second cause for hospitalization at the Pediatric Department of the Maputo Central Hospital in 2006 [76].

Diabetes affected 2.9% of the Mozambican adults in 2005 [77], with significant differences between urban (women: 4.9%; men: 5.5%) and rural areas (women: 1.2%; men: 2.4%). However, only nearly one in ten dwellers with diabetes were aware of the condition [77]. It was estimated that less than one third of expected dwellers with type 2 diabetes were actually being followed in the health system [62].

4.3.2. A call to action

The proportion of the population living in urban areas is increasing worldwide with Asia and Africa urbanizing more rapidly than the other regions of the world; it is projected that in 2050, most of the global urban population (73%) will be concentrated in those two continents. By 2030, almost half of the African population will live in urban area, 8% more than in 2011 [78]. In Mozambique a steep increase in urbanization has also been observed; the percentage of urban population increased from 21% in 1990 to 31% in 2010 and is expected to reach 36% in 2050 [79]. The urban growth often takes place quickly and disproportionately in relation to the number of formal jobs available, leading to a lack of ability of "absorption" by the cities. Furthermore, many private sector employers pay considerably less than the minimum legal wage and the high living costs in the cities tend to be difficult to afford by the urban poor [80]. The rapid and unplanned urbanization enhances poverty and the poor living conditions facilitates the transmission of infectious diseases but also affects the expression of lifestyle behaviors [81].

Urbanization is closely linked with the globalization process which is enhanced by the creation of distribution infrastructures that attract multinational companies, as well as by the development of marketing strategies to promote the “new” imported goods [82]. A greater access to modern mass media, to better transportation systems, and to larger modern supermarkets facilitates the globalization process. Global influences (via advertising or increased availability) contribute to changes in the types of goods consumed [28, 83, 84].

Most of the changes that frequently arise from the urbanization and globalization involve decreases in the consumption of foods rich in fibre such as legumes, fruits, vegetables, whole grains, and a more frequent intake of processed foods frequently energy dense and rich in sugar and salt [29]. The pattern of alcoholic beverages consumption tends to change with increasing availability of commercial beverages [85]; traditional forms of tobacco use also tend to shift to manufactured cigarettes’ smoking, and the frequency of those two behaviours is expected to increase with purchasing power growth [85, 86]. Physical activity patterns, at work, leisure, and travel, are also expected to shift toward reduced energy expenditure [28].

Taking into account that emergent “urban globalized way of living”, discrepancies in the frequencies of lifestyle risk factors between urban and rural areas are expected to exist and to be reflected in the metabolic/physiologic risk factors. In fact, the prevalence of intermediate risk factors for NCD diseases has already an important expression in

Mozambique. In 2005, overweight/obesity affected 18.6% of women and 11.7% of men, and the prevalence of overweight was higher than underweight among urban women [87], a pattern already described in other countries under epidemiological transition. The urban-rural differences were large, being the prevalence of obesity more than six-fold higher in urban than in rural areas [87]. Hypertension affected nearly one third of the adult Mozambicans, with urban-rural differences only among women (41.0% in urban areas vs. 26.8% in rural areas). However, from the hypertensive, only 14.8% were aware of their condition of which 39.9% were treated [88]. The difficult access to health care, in addition to the existing lag between the exposure to risk factors and the corresponding disease manifestation [83], favours the lack of public awareness about the risks.

The repercussions of the exposure to NCD risk factors have increased in the last decades; five of the first eight mortality risks in Mozambique in 2010 are risk factors for NCD while in 1990 only three were directly related to NCD [7]. It is thus unquestionable the transition of risks in a rapidly changing environment. Demographic ageing, urbanization, and the globalization of unhealthy lifestyles, together with the socio-economic development and the decrease in the exposure to maternal, and perinatal risks are powerful are drivers to this shift [89, 90]. The most impressive NCD repercussion change during those two decades respects to the mortality from stroke which shifted from the 12th cause of death in 1990 to the 6th position in 2010.

In this context of transition of mortality and risk profiles, a Department for NCD within the Ministry of Health of Mozambique was created in 2002 and has taken the first steps into NCD prevention and control. The WHO STEPS survey is one of the main inputs on surveillance of the relatively new department. In addition, a study to estimate asthma occurrence in Maputo Central Hospital, and the *Rapid Assessment Protocol for Insulin Access* (RAPIA) was carried out in three of the eleven provinces of Mozambique in order to assess the barriers to care and medicines access for diabetes. Besides those studies, a population based cancer registry was set up in Beira in collaboration with the International Agency for Research on Cancer [62]. In 2008, the Ministry of Health approved the *National Strategic Plan for the Prevention and Control of NCD* aiming at reducing the exposure to risk factors, morbidity and mortality due to NCD. Specific projects in diabetes and hypertension such as creation by the end of 2009 of a consultation for patients suffering from those conditions, creation of National guidelines for the diagnosis and treatment of hypertension, development of education materials, training of health care workers, and promotion of NCD public awareness through public events. It was also recognized the importance of integrating NCD with the control of

other diseases. An example is the beginning of the integration of breast and cervical cancer screening programmes with family planning services since 2010 [62].

Despite the increase in the awareness about the importance to NCD prevention and control in Mozambique, the available resources do not match the real challenges. The government budget allocated to NCD control represents 2.2% of the total national budget for the National Directorate of Public Health and no donors contribute to face this group of diseases except a very small external financial support (in comparison with that approved for HIV/AIDS, tuberculosis and malaria) from the WHO, the World Diabetes Foundation, and the *Diabetes UK* [62].

Although accurate estimates of NCD morbidity and mortality in Mozambique are scarce, the available information from a country under epidemiological transition, suggests that the NCD burden will increase.

5. AIMS

Surveillance on NCD and corresponding risk factors is essential to obtain an accurate characterization of their frequency and distribution over time, as well as to understand and predict the trends in the burden of NCD.

This thesis aimed to characterize the exposure to four major lifestyle risk factors in the adult Mozambican population, and to assess the clustering of the latter and metabolic/physiologic risk factors using *a priori* and *a posteriori* approaches. We also aimed to obtain preliminary exploratory data on dietary intake and culinary practices in Maputo and to quantify the sodium content of bread sold in the same region.

This thesis includes reports from studies with the following specific objectives:

1. **Paper I**

   To describe the alcohol consumption habits in a representative sample of the Mozambican adult population, discriminating binge drinking behavior and the weekday variation in drinking patterns, and to quantify the association between socio-demographic characteristics and alcohol consumption (current drinking and binge drinking);

2. **Paper II**

   To describe fruit and vegetables consumption in a representative sample of the Mozambican adult population according to socio-demographic characteristics [sex, age, education, income and place of residence (urban/rural)];

3. **Paper III**

   To quantify the use of smoked (manufactured/hand-rolled cigarettes) and smokeless (snuffed/chewed) tobacco, according to socio-demographic characteristics [sex, age, education and place of residence (urban/rural)];

4. **Paper IV**

   To assess the socio-demographic determinants of physical activity, by level (low/moderate/high), intensity (moderate/vigorous) and domain (work/transport/recreation), in a representative sample of the Mozambican adult population, across urban and rural areas;

5. **Paper V**

   To estimate the proportion of the Mozambican population in different CV risk categories, according to the WHO/ISH risk prediction charts, as well as the prevalence of eligibility for treatment with antihypertensive drugs, following different criteria, both according to the single risk factor and the total risk approaches;

6. **Paper VI**

   To identify patterns of clustering of CV risk factors (smoking, excessive alcohol drinking, low fruit and vegetables intake, insufficient physical activity, high BP, high body mass index, and high fasting blood glucose), and to quantify their association with socio-demographic characteristics (place of residence, age, and education), in the Mozambican adult population;

7. **Paper VII**

   To report on food consumption and culinary practices of adults living in the city of Maputo, Mozambique;

8. **Paper VIII**

   To estimate the sodium content of white bread available in different selling points in Maputo, Mozambique, including bakeries and traditional markets.

6. METHODS

This thesis was based on a large national survey of the adult population from Mozambique, conducted in 2005 (papers I to VI), and other two studies conducted in Maputo during 2012/2013. The latter included a survey of a convenience sample of the adult general population from city of Maputo (paper VII), and a study of the bread available for purchase in the most important selling points in Maputo (paper VIII).

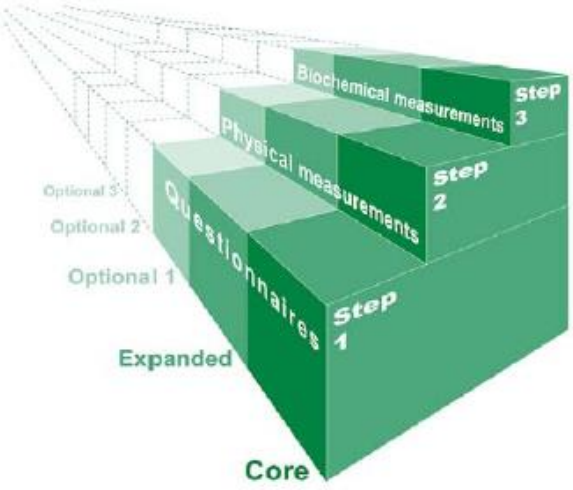
6.1. Papers I to VI

Papers I to VI used the data collected in 2005, following the WHO STEPS approach to NCD risk factors, that was designed to help low and middle income countries to get started on NCD surveillance [91].

The STEPS is a relatively simple and standardized method for collecting, analyzing and disseminating data from WHO member countries. This approach focuses on obtaining core data on modifiable risk factors that determine a high burden of disease, and encourages the collection of small amounts of useful information on a regular and continuing basis. By following the same standardized protocols, the STEPS information may be used both for monitoring within-country trends and international comparisons [91].

This stepwise approach to risk factors surveillance is illustrated in figure 15. Step 1 comprises the gathering of key information on risk factors with a questionnaire on socio-demographic and behavioural data; Step 2 involves data collection through simple physical measurements; and in step 3 blood samples are collected for biochemical analysis [92].

Figure 15. General concept of the WHO STEPS approach.



Source: World Health Organization, 2008 [92].

Within each Step, there are three levels of data collection (core, expanded, and optional information). Both the steps to be considered in the surveys and the levels of detail in data collection (core, expanded, and optional) depend on what can be accomplished (financially, logistically and in terms of human and clinical resources) in each country [92].

In Mozambique the first WHO STEPS assessment was carried out in 2005 and the core information was gathered for the three steps (behavioral, physical and biochemical measurements) whereas the expanded information was also collected for the step 1. The following data was used for the present thesis:

Step 1: Demographic and behavioral information gathered through a structured questionnaire including sex, age, schooling years, and income; tobacco use (smoking and smokeless; past, occasional and daily use; type and quantity daily used); alcohol consumption (usual weekly frequency and quantity in the previous 12 months and daily consumption in the previous week; frequency and quantity of binge drinking in the previous 12 months); diet (usual frequency and quantity of fruit and vegetables intake in the previous 12 months); physical activity (Global Physical Activity Questionnaire – GPAQ [93] which includes work, transport, and recreational physical activity); and history and treatment of diabetes and high BP;

Step 2: Physical measurements including weight, height and BP;

Step 3: Collection of blood samples for biochemical analysis (fasting blood glucose).

A sample of adults aged 25 to 64 years was assembled using the sampling frame of the Mozambican 1997 census [94]. Homeless and people living in collective residential institutions (*e.g.* hotels, hospitals, military facilities) were not eligible. This survey followed a complex sampling design with clustering at a geographical unit level and at the household level, as well as stratification by province. This complex sampling design comprised the random selection of 95 geographical clusters, among which all of the households were listed and 25 randomly selected and visited. All of the eligible subjects in the same household were invited for the study.

The number of geographical clusters and the number of households per cluster were defined aiming to select approximately 2800 participants, ensuring the sample representativeness at a national level and by place of residence (urban or rural), and taking into account the expected number of eligible subjects per household according to the population estimates for the study period [95]. There was no substitution of the households in which no one answered the door and the inquirers were instructed to make several attempts

to contact members of the selected households at different times and in different days to minimize selection bias. The number of subjects invited was 3378, from which 55 subjects refused to participate and 3323 (98.4% of the invited) were evaluated between September and November 2005.

Trained interviewers conducted face-to-face interviews in each household, assessed the physical measurements and collected blood samples from each participant [92]. A Portuguese version of the WHO STEPS instrument for NCD risk factors (core and expanded version 2.1) [96] was used for data collection.

The study protocol was approved by the National Mozambican Ethics Committee and written informed consent was obtained from all participants, according to the World Medical Association's Declaration of Helsinki.

6.2. Paper VII

We conducted a cross-sectional evaluation of a convenience sample of the adult general population aged 25-64 years, from Maputo city (n=50). An equitable distribution of the participants according to sex, age (with similar distribution below and above 44 years) and family income (with similar distribution of subjects with an income below and above 3 minimum salaries) was ensured. Participants belonged to different households and were interviewed between October 2012 and February 2013 at the Maputo Central Hospital.

By morning, a trained interviewer collected dietary intake data using a single 24-hour dietary recall. Participants were asked to report all foods and beverages consumed during the previous 24 hours, including those items ingested outside of the home. They were prompted to report the amounts consumed and to specify the brand of the processed foods and beverages, the name of the dishes, the culinary methods and practices including the ingredients of each culinary preparation. Detailed information about the type and amount of added fat, sugar, salt and other seasonings are examples of practices asked to report. Portion sizes were assessed using a quantification album with pictures of common household measures, such as spoons, plates, cups and glasses [97].

The study protocol was approved by the National Bioethics Commission for Health and written informed consent was obtained from all participants, according to the World Medical Association's Declaration of Helsinki.

6.3. Paper VIII

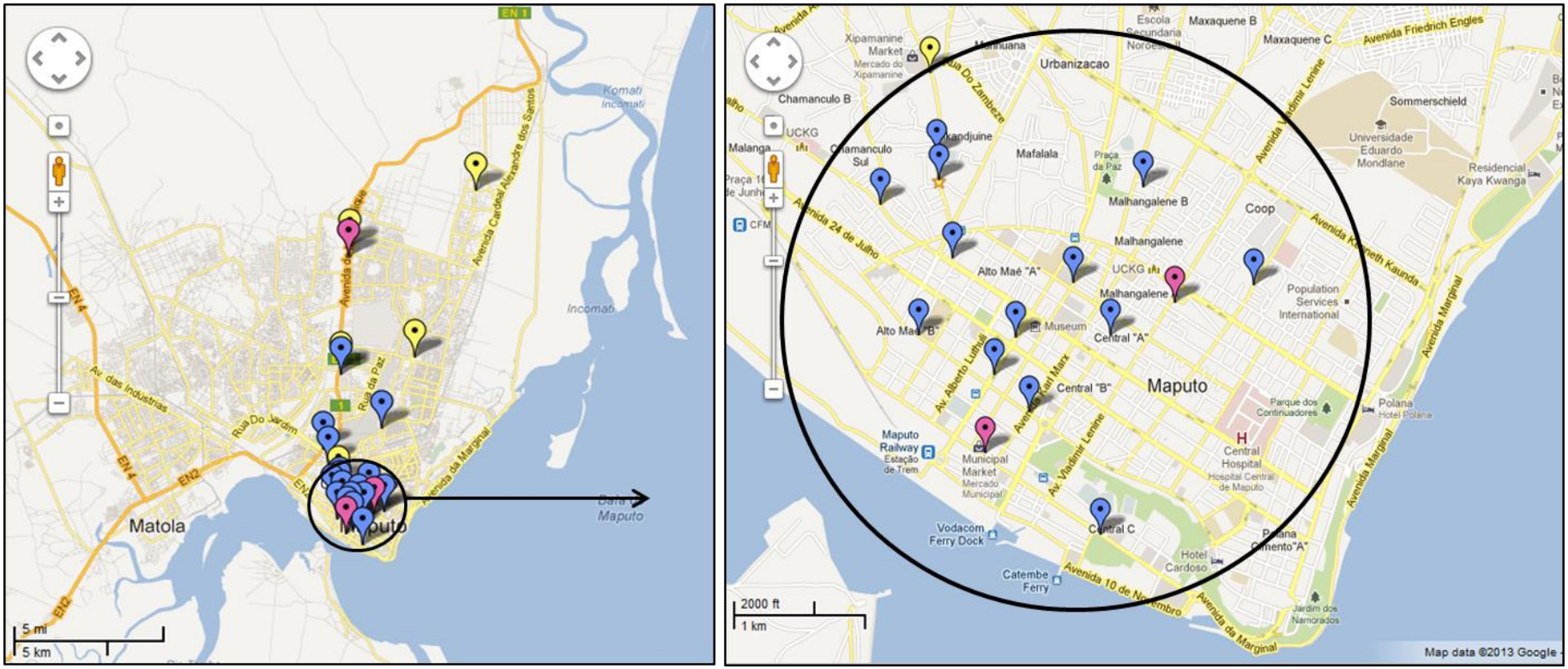
For this study we selected all the bakeries from Maputo city listed in the Mozambican yellow pages (n=16) [98], as well as the major traditional markets in the same area, including officially organized retail outlets confined to an area fitted for the purpose (formal traditional markets, n=3) and non-organized street markets (informal traditional markets, n=5). Additionally, we identified a well-known bakery chain with four retail stores and included their head office bakery in our sample of selling points, increasing to 17 the number of bakeries visited (Figure 16).

In June 2012 we bought, by morning, three white wheat fresh breads in each of the 25 points of sale, and noted their prices. Only one type of bread (white wheat bread) and one shape (either round or elongated) was available in the selected selling points. In nine bakeries/markets two different sizes of bread were available and in those cases we took a sample of the smaller.

Each group of three breads was then weighted, packed in proper cooler bags (one bag for each point of sale) and frozen at -18 °C until sodium content analysis.

After defrost at room temperature, the groups of three breads from each selling point were weighed and grinded mechanically for homogenization of each sample. After homogenization, three 2 g aliquots were collected and prepared for sodium determination, according to a previously validated method, described in detail elsewhere [99]. Briefly, the sodium existing in the bread is dissolved in doubly deionized water and quantified by flame photometry (flame photometer model PFP7, JenWay®, England).

Figure 16. Geographical distribution of points of sale of bread in Maputo, Mozambique, including bakeries (blue), and formal (pink) and informal (yellow) traditional markets.



7. PAPERS

Paper I

Padrão P, Damasceno A, Silva-Matos C, Laszczyńska O, Prista A, Gouveia L, Lunet N. Alcohol consumption in Mozambique: regular consumption, weekly pattern and binge drinking. Drug Alcohol Depend 2011; 115(1-2): 87-93.

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Alcohol consumption in Mozambique: Regular consumption, weekly pattern and binge drinking

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ABSTRACT

This study aimed to describe alcohol consumption in Mozambique, discriminating binge drinking behaviour and the weekday variation in drinking patterns, and to quantify the association between socio-demographic characteristics and alcohol intake.

A representative sample of 3265 Mozambicans aged 25–64 years was evaluated in 2005 following the World Health Organization Stepwise approach to Chronic Disease Risk Factor Surveillance (STEPS). The consumption of any type of alcoholic beverage, during life and in the previous year, was recorded. Current drinkers were also asked about the number of standard drinks consumed in each day of the previous week.

The overall prevalence of current dinking was 28.9% [95% confidence interval (95% CI): 22.6–35.2] in women and 57.7% (95% CI: 49.8–65.7) in men. Forty percent of the current drinkers reported to have had at least one binge drinking occasion in the previous week. The prevalence of current drinking increased with age and education among women and with income among men. No consistent pattern was observed in binge drinking by education in both genders and by annual income among men, but it was significantly less frequent among the more affluent women. Both drinking and binge drinking peaked at the weekend.

Knowing the drinking patterns in Mozambique enables the planning of interventions according to the local needs. Future surveys should also include non-adult populations as risk factors for chronic diseases occurs as early as childhood and adolescence, and are associated with increased risk of disease later in life.

Paper II

Padrão P, Damasceno A, Silva-Matos C, Laszczyńska O, Prista A, Gouveia L, Lunet N. Low fruit and vegetable consumption in Mozambique: results from a national STEPS survey. Br J Nutr 2012; 107(3): 428-35.

British Journal of Nutrition (2012), **107**, 428–435 doi:10.1017/S0007114511003023

Low fruit and vegetable consumption in Mozambique: results from a WHO STEPwise approach to chronic disease risk factor surveillance

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Abstract

Monitoring food consumption and its determinants over time is essential for defining and implementing health promotion strategies, but surveillance is scarce in Africa. The present study aimed to describe fruit and vegetable consumption in Mozambique according to socio-demographic characteristics and place of residence (urban/rural). A national representative sample (*n* 3323) of subjects aged 25–64 years was evaluated in 2005 following the WHO Stepwise Approach to Chronic Disease Risk Factor Surveillance, which included an assessment of usual fruit and vegetable consumption (frequency and quantity). Crude prevalence and age-, education- and family income-adjusted prevalence ratios (PR) with 95 % CI were computed. Less than 5 % of the subjects reported an intake of five or more daily servings of fruits/vegetables. Both fruits and vegetables were more often consumed by women and in rural settings. In urban areas, the prevalence of fruit intake (≥2 servings/d) increased with education (≥6 years *v.* <1 year: women, adjusted PR = 3·11, 95 % CI 1·27, 7·58; men, adjusted PR = 3·63, 95 % CI 1·22, 10·81), but not with income. Conversely, vegetable consumption (≥2 servings/d) was less frequent in more educated urban men (≥6 years *v.* < 1 year: adjusted PR = 0·30, 95 % CI 0·10, 0·94) and more affluent rural women (≥$801 US dollars (USD) *v.* $0–64: adjusted PR = 0·32, 95 % CI 0·13, 0·81). The very low intake of these foods in this setting supports the need for fruit and vegetable promotion programmes that target the whole population, despite the different socio-demographic determinants of fruit and vegetable intake.

Key words: **Fruits: Vegetables: Africa: Mozambique**

Padrão P, Damasceno A, Silva-Matos C, Laszczyńska O, Prista A, Gouveia L, Lunet N, Low fruit and vegetable consumption in Mozambique: results from a national STEPS survey, British Journal of Nutrition, 107, 3, 428-35, 2012, reproduced with permission.

Paper III

Padrão P, Damasceno A, Silva-Matos C, Carreira H, Lunet N. Tobacco Consumption in Mozambique: Use of Distinct Types of Tobacco across Urban and Rural Settings. Nicotine Tob Res. 2013; 15(1): 199-205.

Original Investigation

Tobacco Consumption in Mozambique: Use of Distinct Types of Tobacco Across Urban and Rural Settings

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Abstract

Introduction: Monitoring tobacco consumption patterns is essential to define and evaluate strategies to control the tobacco epidemic. We aimed to quantify the use of smoked (manufactured/hand-rolled cigarettes) and smokeless (snuff/chew) tobacco, according to sociodemographic characteristics, in adult Mozambicans.

Methods: A national representative sample ($n = 3,323$) of subjects aged 25–64 years was evaluated in 2005 following the World Health Organization Stepwise Approach to Chronic Disease Risk Factor Surveillance (STEPS), which included the assessment of tobacco consumption with the quantification of each type of tobacco used daily. We computed prevalences, and age- and education-adjusted prevalence ratios (*PR*s), with 95% *CI*s.

Results: Daily smoking was reported by 9.1% (95% *CI* = 5.0–13.1) of women (manufactured, 3.4%; hand-rolled, 5.6%) and 33.6% (95% *CI* = 29.3–38.0) of men (manufactured, 18.7%; hand-rolled, 14.8%). Daily manufactured cigarette smoking was significantly more frequent in men (urban: *PR* = 14.62, 95% *CI* = 7.59–28.55; rural: *PR* = 4.32, 95% *CI* = 2.42–7.71). Daily hand-rolled cigarette smoking was three- to fourfold more frequent among men and nearly 80% less frequent in urban areas, regardless of sex. The prevalence of daily smokeless tobacco use was 7.4% (95% *CI* = 4.6–10.2) in women (chew, 6.4%; snuff, 1.0%) and 3.4% (95% *CI* = 1.7–5.2) in men (chew, 1.6%; snuff, 1.8%). Daily smokeless tobacco consumption was significantly less frequent in urban areas only among men (*PR* = 0.05, 95% *CI* = 0.01–0.33).

Conclusions: Despite the relatively low levels of manufactured cigarette smoking, traditional forms of tobacco consumption are frequent, especially among women and in rural settings, showing the need for control measures to target specifically different patterns of consumption.

Padrão P, Damasceno A, Silva-Matos C, Carreira H, Lunet N. Tobacco Consumption in Mozambique: Use of Distinct Types of Tobacco across Urban and Rural Settings. Nicotine and Tobacco Research, 2013, 15, 1, 199-205, by permission of Oxford University Press.

Paper IV

Padrão P, Damasceno A, Silva-Matos C, Prista A, Lunet N. Physical activity patterns in Mozambique: Urban/rural differences during epidemiological transition. Prev Med. 2012; 55(5): 444-9.

Preventive Medicine 55 (2012) 444–449

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Physical activity patterns in Mozambique: Urban/rural differences during epidemiological transition

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STEPS
Africa
Mozambique

ABSTRACT

Objective. To assess the socio-demographic determinants of physical activity, by intensity and domain, across urban and rural areas in Mozambican adults.

Method. A national representative sample (n = 3323) of subjects aged 25–64 years was evaluated in 2005 following the World Health Organization (WHO) Stepwise Approach to Chronic Disease Risk Factor Surveillance (STEPS), which includes the Global Physical Activity Questionnaire. We computed prevalences, and age- and education-adjusted prevalence ratios (PR), with 95% confidence intervals (95%CI).

Results. Most of the Mozambicans reported a high physical activity level, according to the WHO criteria (urban women: 83.2%, 95%CI 77.4, 89.0; rural women: 93.2%, 95%CI 89.0, 97.3; urban men: 78.9%, 95%CI 74.7, 83.1; rural men: 91.6%, 95%CI 85.5, 97.6). The prevalences of <75 min/week of vigorous activities were higher in urban settings (women: PR = 2.21; men: PR = 2.28) and increased with education, regardless of place of residence (PR ranging between 1.75 and 5.72 for more vs. less educated subjects). Work activities were the most important contributor to the overall physical activity, followed by transport.

Conclusion. Most of the Mozambicans reported to be physically active. Vigorous activities were less common in urban areas and among the more educated subjects, depicting an ongoing shift to more sedentary behaviours in this setting.

Paper V

Damasceno A, Padrão P, Silva-Matos C, Prista A, Azevedo A, Lunet N. Cardiovascular risk in Mozambique: who should be treated for hypertension? J Hypertension [in press].

Cardiovascular risk in Mozambique: who should be treated for hypertension?

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[In press]

Abstract

Aim: To estimate the proportion of Mozambicans eligible for pharmacological treatment for hypertension, according to single risk factor and total cardiovascular risk approaches.

Methods: A representative sample of Mozambicans aged 40-64 years (n=1116) was evaluated according to the World Health Organization (WHO) STEPwise Approach to Chronic Disease Risk Factor Surveillance (STEPS). We measured blood pressure (BP) and 12-hour fasting blood glucose levels and collected data on sociodemographic characteristics, smoking, and use of antidiabetic and antihypertensive drugs. We estimated the 10-year risk of a fatal or non-fatal major cardiovascular event (World Health Organization/International Society of Hypertension risk prediction charts), and computed the proportion of untreated participants eligible for pharmacological treatment for hypertension, according to BP values alone and accounting also for the total cardiovascular risk (WHO guidelines for assessment and management of cardiovascular diseases).

Results: Among the Mozambicans aged 40-64 years and not taking antihypertensive drugs, less than 4% were classified as having CV risk ≥20% whereas the prevalence of systolic/diastolic BP ≥140/90 mmHg was nearly 40%. A total of 19.8% of 40-64 year-olds would be eligible for pharmacological treatment of hypertension according to the WHO guidelines, all of whom had systolic/diastolic BP≥160/100 mmHg.

Conclusions: Among the Mozambicans aged 40-64 years not taking anti-hypertensive drugs and having systolic/diastolic BP≥140/90 mmHg, only half were eligible for pharmacological treatment according to the WHO guidelines. Taking the latter into account when defining strategies to control hypertension at a population level, may allow a more efficient use of the scarce resources available in developing settings.

Key words: Hypertension; Diabetes Mellitus; Smoking; Risk Assessment; Mozambique.

Introduction

Cardiovascular (CV) diseases are the leading cause of death worldwide [1], estimated to become responsible for almost 25 million deaths by 2030, mostly from heart disease and stroke [2]. Although the mortality rates have been declining in industrialized countries since the late twentieth century [3], they are rapidly increasing in most developing nations [4].

In Mozambique, hypertension affects one-third of the adult population [5] and CV diseases already have an important public health impact [6-8], especially stroke, and mainly among older dwellers from urban areas [9]. In 1994 cerebrovascular diseases were the leading cause of death among Maputo inhabitants aged over 60 [6]. Between 2005 and 2006 the incidence of stroke hospitalization in Maputo was estimated to be 148.7 per 100 000, one of the highest in developing settings [7], and the early case-fatality rates were also high [8].

The Framingham Heart Study led the way to the development of CV risk prediction equations for assessment of absolute risk that have resulted in a paradigm shift in prevention strategies, from addressing a single risk factor (e.g. hypertension) to a more cost-effective total CV risk approach [10]. More recently, the World Health Organization (WHO) and the International Society of Hypertension (ISH) developed a tool that enables CV risk assessment in low income countries [11].

Thus, we aimed to estimate the proportion of the Mozambican population in different CV risk categories, according to the WHO/ISH risk prediction charts, as well as the prevalence of eligibility for treatment with antihypertensive drugs, following different criteria, both according to the single risk factor and the total risk approaches.

Methods

The present study was based on a survey that evaluated a representative sample of the Mozambican adults aged 25 to 64 years, between September and November 2005, as previously described in detail [5]. Briefly, using a sampling frame derived from the 1997 Mozambican census, 95 geographical clusters were selected across 11 strata (provinces). In each cluster all the households were listed and 25 randomly selected and visited. In each household selected, all the subjects in the eligible age-range were invited to participate (n=3378); 55 refused and the remaining (98.4% of the invited) were evaluated at their homes by trained interviewers, following the WHO STEPwise approach to chronic disease risk factor surveillance (STEPS) [12]. This comprised a face-to-face interview using a structured questionnaire to collect information on sociodemographic characteristics, lifestyles (including tobacco smoking) and medical history (including the use of antihypertensive and antidiabetic drugs), as well as physical measurements [including blood pressure (BP)], and the assessment of 12-hour fasting glucose levels.

The classification of the place of residence as urban (in any of the 23 cities and 68 towns) or rural (outside cities or towns) and the definition of categories for the highest level of education attained (<1; 1-5; ≥6 years) were done in accordance with the 1997 census [13].

To assess the smoking status the participants were asked if they currently smoked any tobacco product, including manufactured cigarettes, hand-rolled cigarettes, cigars and pipe. Subjects were also asked whether they smoked in the past on a daily basis and ex-smokers were asked how long ago they quit smoking. Participants who were smokers at the time of the interview and ex-smokers who stopped smoking for less than one year were classified as smokers, according to the WHO guidelines for assessment and management of CV risk [14].

BP was measured in the sitting position on a single occasion by nonphysician trained interviewers using a semiautomatic sphygmomanometer (Omron 3®) with an appropriate cuff size. After a 5-minute rest, BP was measured twice, one minute apart, and a third measurement was performed if the difference between the first two was >10 mmHg for systolic or diastolic BP. For analysis, we used the mean of the two measurements or the mean of the last two when three measurements were taken.

Subjects reporting the use of antihypertensive drugs in the previous two weeks were considered to be treated pharmacologically for hypertension and were not further considered for data analysis. The untreated participants (93%) were grouped according to the

systolic/diastolic BP cutoffs that underlie the WHO eligibility criteria for treatment with antihypertensive drugs, namely ≥130/80 and <140/90, ≥140/90 and <160/100, and ≥160/100 mmHg [15].

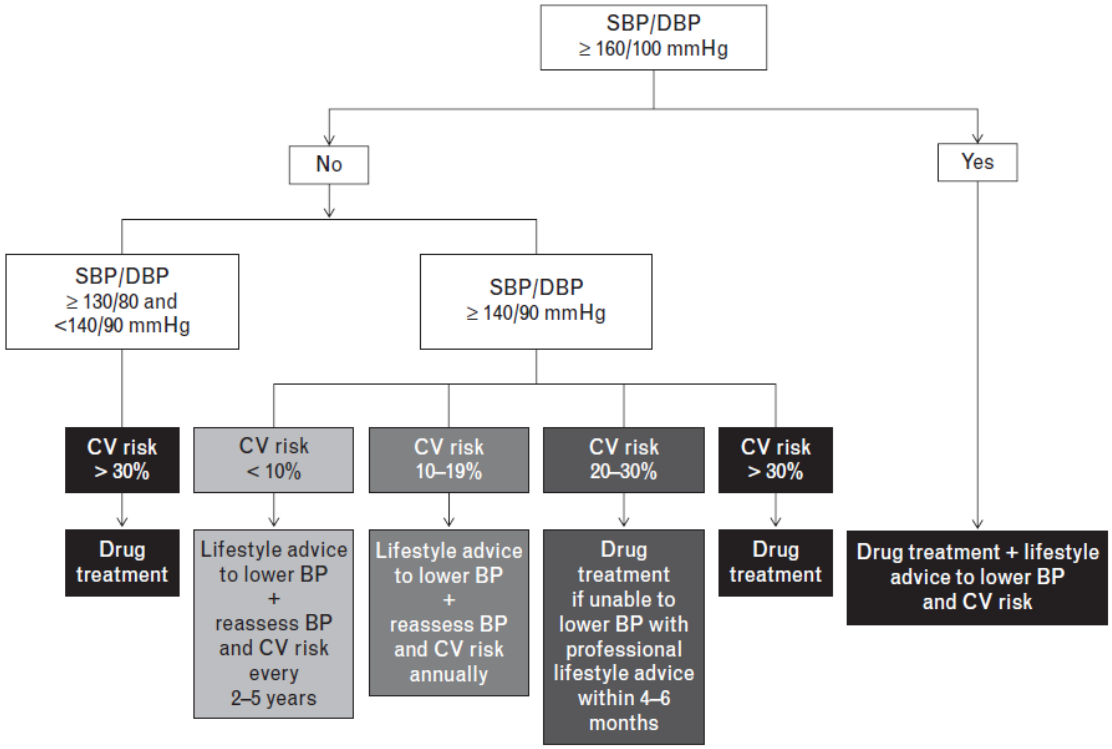
Twelve-hour fasting blood glucose (FBG) levels were obtained in accordance with WHO standardized fingertip prick tests, using calibrated blood glucose meters and reagent strips (Accu-Chek® Advantage meter). Participants who reported to have diabetes diagnosed by a health professional within the previous 12 months were asked whether they currently use insulin or oral blood glucose lowering drugs. Subjects were classified as having diabetes when their FBG concentration was above 7.0 mmol/l, or when reporting to take insulin or oral antidiabetic drugs [14].

The WHO/ISH prediction charts for Africa E sub region were used to classify each participant regarding the individual absolute CV risk, based on sex (male/female), age (40-49, 50-59, and >59 years), current smoking status (non-smoker/smoker), systolic BP (<140, 140-159, 160-179, and ≥180 mmHg), and diabetes (presence/absence).

The WHO/ISH prediction charts estimate the 10-year risk of a fatal or non-fatal major cardiovascular event (myocardial infarction or stroke) expressed in four categories: <10% (low), 10-19% (moderate), 20-29% (high), ≥30% (very high), in people who do not have established CV diseases [14].

The eligibility for treatment with antihypertensive drugs was defined according to the single risk factor approach (systolic/diastolic BP ≥140/90 mmHg or systolic/diastolic BP ≥160/100 mmHg), and according to the WHO guidelines for assessment and management of CV risk [15]. The WHO guidelines recommend that all individuals with persistent BP ≥160/100 mmHg, and those with total risk ≥30% with persistent BP ≥130/80 mmHg, should be submitted to drug treatment, in addition to receiving specific lifestyle advice to lower their BP and risk of CV diseases. Antihypertensive drugs are also recommended to individuals with risk ≥20% with persistent BP ≥140/90 mmHg who are unable to lower BP through lifestyle strategies with professional assistance within 4-6 months [14] (Figure 1).

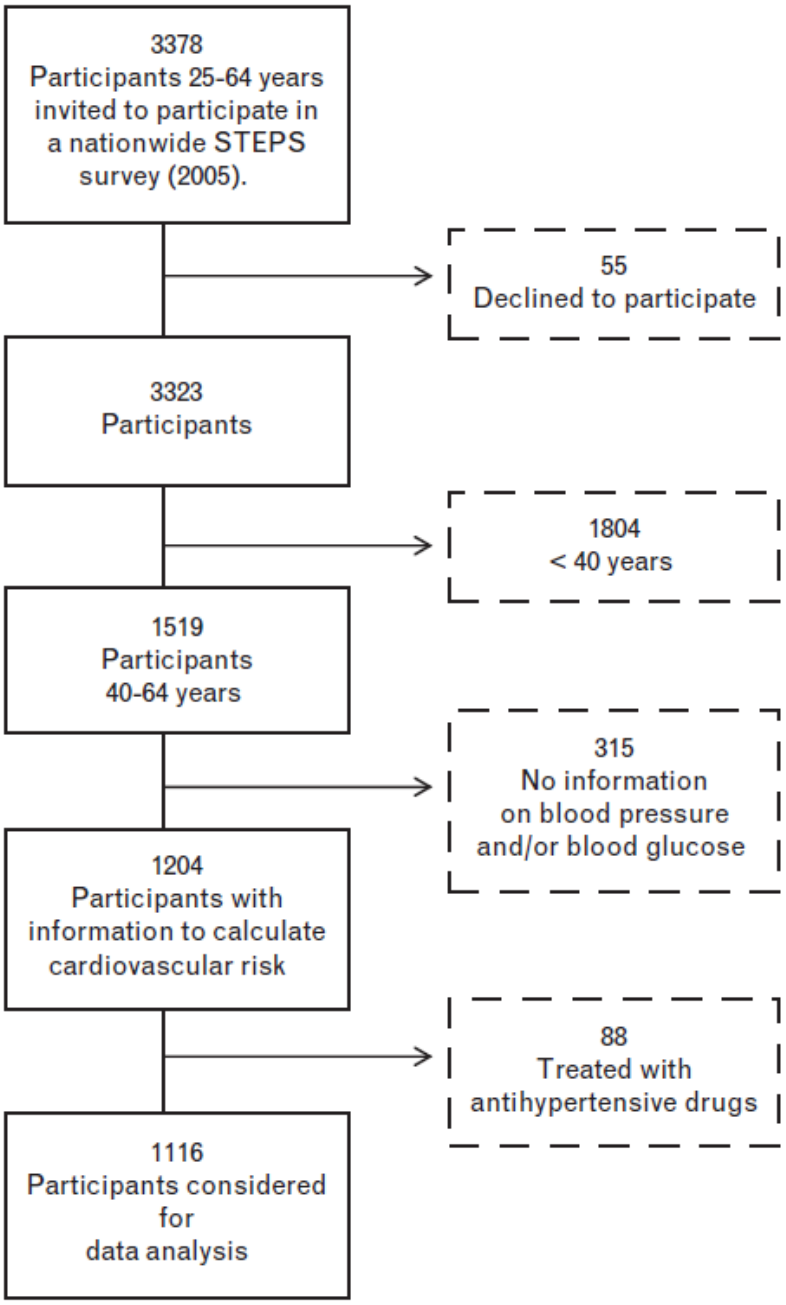
Figure 1. Criteria used to define eligibility for pharmacological treatment for hypertension, according to World Health Organization guidelines [15].



Statistical analysis

For the present analyses only the participants aged 40 or more years were considered since those are the target population of the WHO/ISH prediction charts. From a total of 1519 participants aged 40-64 years, 315 were excluded due to missing information on BP and/or blood glucose; the latter were not significantly different from the 1204 participants considered for analysis regarding place of residence, sex, age or education. Participants who did not follow the 12-hour of fasting or with no information regarding the fulfilment of this prerequisite (n=100) were not excluded; these were less educated (≥6 years: 10.6% vs. 20.9%, P=0.012), but not significantly different from the remaining regarding place of residence, sex or age. We further excluded 88 subjects that were being treated with antihypertensive drugs, and 1116 participants were considered for data analysis (Figure 2).

Figure 2. Flow-chart of the selection of participants for the present study.



SBP/DBP, systolic blood pressure/diastolic blood pressure; BP, blood pressure; CV, cardiovascular.

We estimated the proportion of subjects included in different categories of CV risk and considering different criteria to define eligibility for treatment with antihypertensive drugs, by sociodemographic characteristics. Adjusted prevalences and respective 95% confidence intervals (95%CI) were computed through unconditional logistic regression.

Data analysis was conducted using STATA, version 11.2. Since stratified sampling resulted in a similar number of participants across strata with unequal population size sampling weights were computed taking into account the number of subjects evaluated in each stratum in relation to the number of participants expected per stratum, according to the population projections for the same period [16]. All analyses were conducted considering the sampling weights, to ensure that the computed estimates reflect the prevalence in Mozambique. The standard errors were estimated taking into account the effect of stratification, and clustering at the primary sampling unit level. All statistical tests were two-sided.

Ethics

The study protocol was approved by the National Mozambican Ethics Committee and written informed consent was obtained from all participants.

Results

Characteristics of the study sample

Approximately two-thirds of the population under study lived in rural areas, nearly 15% were older than 59 years, and almost half of the subjects had no formal education. Nearly 40% of the subjects showed a systolic BP above 139 mmHg, and approximately 2% were classified as having diabetes. Smoking was reported by approximately one-third of the population (Table 1).

Table 1. Characteristics of the participants.

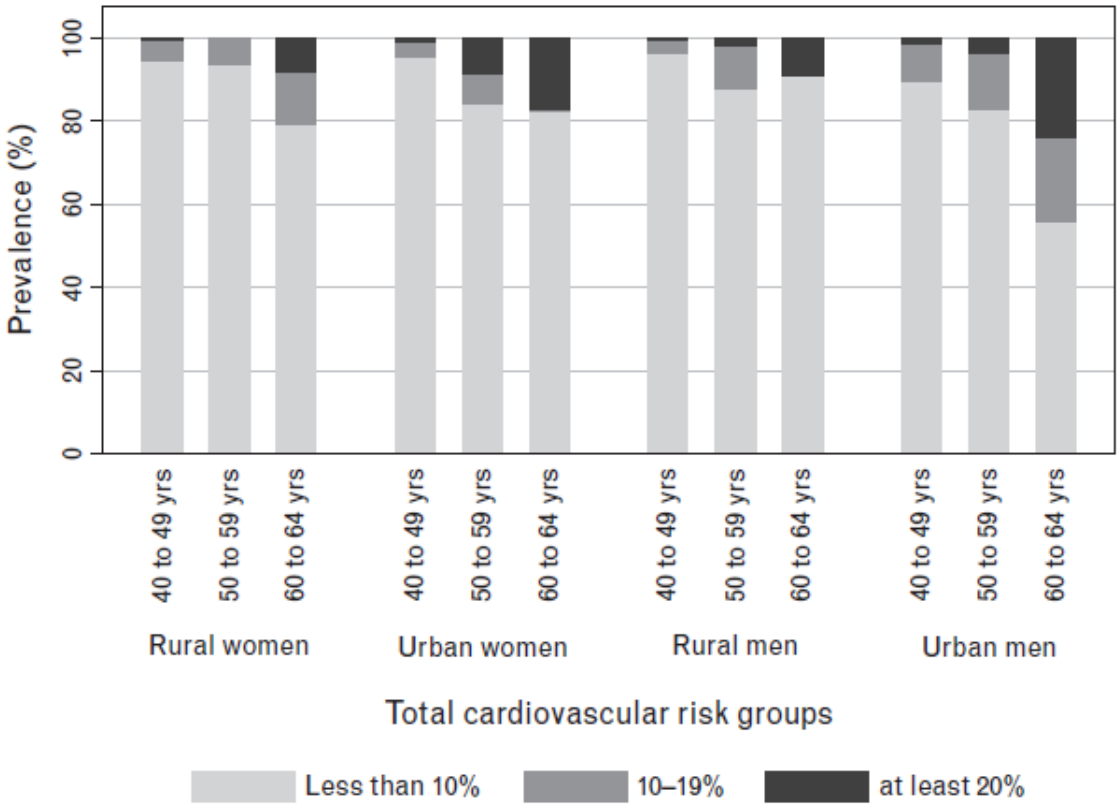
	Participants (n=1116)		
	n	Unweighted (%)	Weighted (%)
Place of residence			
Urban	549	49.2	31.8
Rural	567	50.8	68.2
Sex			
Women	629	56.4	51.7
Men	487	43.6	48.3
Age (years)			
40 to 49	603	54.2	52.8
50 to 59	348	31.3	31.7
60 to 64	161	14.5	15.5
Education (years)			
<1	427	38.3	45.9
≥1 and <6	514	46.1	42.7
≥6	174	15.6	11.4
Systolic blood pressure (mm Hg)			
<140	627	56.2	61.3
≥140 and <160	257	23.0	21.7
≥160 and <180	138	12.4	10.3
≥180	94	8.4	6.7
Diabetes *	26	2.3	1.8
Smoking	320	28.7	33.9

* Fasting blood glucose >7.0 mmol/l or treatment with insulin or oral hypoglycaemic drugs.

Total CV risk

Most of the participants were classified as having low (<10%) 10-year CV risk (90.2%; 95%CI: 87.0-93.3). The prevalences were 6.7% (95%CI: 4.0-9.4), 1.7% (95%CI: 0.8-2.5), and 1.4% (95%CI: 0.5-2.3), for the CV risk categories 10 to 19%, 20 to 29%, and ≥ 30%, respectively. The prevalence of total CV risk ≥ 20% increased with age and was higher among the urban participants (Figure 3).

Figure 3. Prevalence of total cardiovascular risk groups among Mozambicans aged 40-64 years, according to place of residence, sex and age.

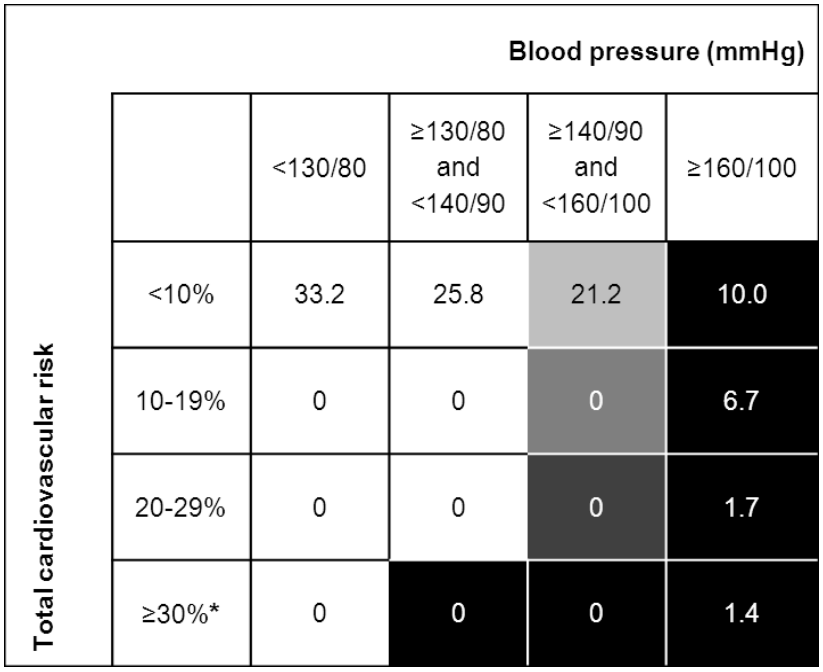


Eligibility for treatment with antihypertensive drugs

All the subjects eligible for treatment with antihypertensive drugs according to the WHO guidelines for assessment and management of CV risk (19.8%) also had systolic/diastolic BP≥160/100 mmHg, and most of these were classified as having low (<10%) CV risk. Approximately one-fifth of the overall sample was estimated to have a CV risk under 10% but systolic/diastolic BP ≥140/90 mmHg, meeting therefore the criteria for continuing lifestyle strategies to lower BP and to have their BP and total CV risk reassessed every 2-5 years depending on clinical circumstances and resource availability (Figure 4). Among the diabetic

subjects, 58.6% were eligible for treatment with antihypertensive drugs and 14.7% had systolic/diastolic BP≥140/90 but total CV risk <10%.

Figure 4. Prevalence of Mozambicans aged 40-64 years eligible for pharmacological treatment for hypertension according to World Health Organization guidelines [15].



* Only one participant was classified with total cardiovascular risk ≥40%
■ – eligible for drug treatment and specific lifestyle advice to lower blood pressure and total cardiovascular risk (19.8%).
■ – eligible for drug treatment if unable to lower blood pressure through lifestyle strategies with professional assistance within 4-6 months (0%).
■ – eligible to continue lifestyle strategies to lower blood pressure and reassess blood pressure and total cardiovascular risk annually (0%).
■ –eligible to continue lifestyle strategies to lower blood pressure and reassess blood pressure and total cardiovascular risk every 2-5 years (21.2%).

The prevalence of eligibility for pharmacological treatment of hypertension was 41.0% if all subjects with systolic/diastolic BP≥140/90 mmHg were to be considered and 19.8% according to the WHO guidelines. The prevalences were higher in urban areas and among women, and increased with age regardless of the criteria used. There were also higher proportions of more educated subjects eligible for treatment, though the differences were not statistically significant (Table 2).

Table 2. Prevalences of eligibility for treatment with antihypertensive drugs according to different criteria, and sociodemographic characteristics.

	Eligibility for treatment with antihypertensive drugs			
	WHO criteria *		Systolic/diastolic BP≥140/90	
	Prevalence (95%CI)		Prevalence (95%CI)	
	Crude	Adjusted †	Crude	Adjusted †
All	19.8 (15.0-24.6)	25.4 (19.1-31.6)	41.0 (34.3-47.8)	46.2 (37.0-55.3)
Place of residence				
Rural	15.8 (10.1-21.6)	21.6 (14.2-28.9)	36.0 (27.5-44.5)	41.4 (30.6-52.1)
Urban	28.3 (21.9-34.7)	35.2 (26.4-43.9)	51.7 (44.6-58.8)	56.8 (46.9-66.7)
P	0.011	0.018	0.011	0.014
Sex				
Women	21.8 (17.3-26.4)	29.7 (21.0-38.4)	44.9 (37.6-52.2)	52.1 (40.6-63.7)
Men	17.6 (11.5-23.8)	21.2 (15.1-27.2)	36.9 (29.0-44.8)	39.8 (31.3-48.3)
P	0.125	0.037	0.034	0.012
Age (years)				
40 to 49	13.9 (9.7-18.0)	13.1 (8.5-17.7)	35.0 (26.5-43.4)	36.5 (28.5-44.5)
50 to 59	24.2 (17.9-30.4)	25.4 (19.1-31.6)	42.2 (33.7-50.7)	46.2 (37.0-55.3)
60 to 64	31.3 (17.1-45.4)	34.0 (21.1-47.0)	59.2 (48.6-69.8)	64.6 (52.2-77.1)
P	<0.001	<0.001	0.002	0.001
Education (years)				
<1	17.8 (11.5-24.2)	21.3 (14.8-27.8)	37.9 (28.0-47.8)	38.8 (29.0-48.6)
1 to 6	20.2 (15.1-25.2)	25.4 (19.1-31.6)	43.1 (36.1-50.1)	46.2 (37.0-55.3)
≥6	26.2 (17.4-35.0)	32.0 (18.0-46.0)	45.6 (36.2-55.1)	46.4 (34.5-58.2)
P	0.345	0.298	0.472	0.431

95%CI, 95% confidence interval; WHO, World Health Organization; BP, blood pressure.

* In this sample the results for the WHO criteria and when considering systolic/diastolic BP≥160/100 are the same;

† Prevalences adjusted for the remaining variables presented in the table, considering the observed proportion of male participants and living in urban areas and the age and education categories with the largest number of participants.

Discussion

Among the Mozambicans aged 40-64 years, less than 4% were classified as having CV risk ≥20% whereas the prevalence of systolic/diastolic BP ≥140/90 mmHg was nearly 40%. According to the WHO guidelines for assessment and management of CV diseases, almost one-fifth of the participants would be eligible for treatment with antihypertensive drugs.

In 2009, we reported on the prevalence, awareness, treatment and control of hypertension in adult Mozambicans [5]; one of the most important findings was that less than 10% of the subjects classified as hypertensive were under pharmacological treatment. The present study adds to our previous research on this topic the assessment of the 10-year risk of a fatal or non-fatal major CV event in the population aged ≥40 years that was not receiving pharmacological treatment for hypertension. This provided the basis to estimate the proportion of subjects eligible for treatment with antihypertensive drugs according to different criteria, including those defined in the WHO guidelines for assessment and management of CV diseases, which account simultaneously for the levels of BP and the total CV risk. However, some potential limitations need to be discussed.

We used the WHO/ISH prediction charts for settings in which blood cholesterol cannot be measured, since no such data was available in our study [11]. In the clinical context lipid assays may also be used only in patients with high cardiovascular risk defined by other criteria, and therefore not considering cholesterol in a risk-prediction model does not necessarily limit the ability to assess cardiovascular risk at a population level [17].

We opted to include in the analyses the participants who did not follow the 12-hour fasting or with no information regarding the fulfilment of this prerequisite. This may have contributed to an overestimation of the CV risk, but is expected to have a minor impact in our results and conclusions, given the very low prevalence of diabetes in this population.

BP was measured on a single occasion instead of two occasions as recommended by the WHO/ISH [15] which may have contributed to an overestimation of BP [18] and consequently CV risk and prevalence of eligibility for treatment with antihypertensive drugs. Nevertheless, among subjects classified as having systolic/diastolic BP ≥160/100 mmHg the mean systolic and diastolic BP was 176 and 97 mmHg, respectively. Furthermore, this is not expected to compromise the comparison of estimates of eligibility according to different criteria.

People with established CV diseases, namely angina or intermittent claudication, or who have had a myocardial infarction, transient ischaemic attack, or stroke, should be considered at very high CV risk of coronary, cerebral and peripheral vascular events and death, regardless of their risk factor levels. Although we do not have such information in this study, the prevalence of these

conditions is expectedly low, due to the high case-fatality associated with major cardiovascular events [7, 8].

According to the WHO guidelines, the subjects with CV risk between 20% and 29% and systolic/diastolic BP ≥140/90 mmHg and <160/100 mmHg are eligible for drug treatment if unable to lower BP through lifestyle strategies with professional assistance within 4-6 months. Although the latter information was not available in our STEPS survey, there were no participants in this category.

Our estimates of the CV risk distribution in Mozambique are in line with those described in Seychelles [19] and in Nigeria [20], where the prevalence of total CV risk ≥20% was 5%, and similar figures were reported in other non-African low and middle income countries [20, 21]. In a survey aiming at estimating the total CV risk in eight countries from different regions, the proportion of the population with CV risk ≥20% ranged from 1.1% in China to 10.0% in Pakistan [20]. More recently, in a study based on data from STEPS surveys conducted in Asian countries [21] the prevalence of WHO/ISH CV risk ≥20% was 1.3% in Camboja, 2.3% in Malaysia, and 6% in Mongolia. In these multi-country surveys the prevalence of BP ≥140/90 mmHg was 3 to 20 fold higher than the prevalence of high and very high CV risk (≥20%), in accordance with our observations in Mozambique.

The total CV risk approach seems to be more cost effective to prevent CV events than the single risk factor approach. Gaziano et al. compared six strategies for initiation of drug treatment – two based on BP levels alone (systolic/diastolic BP: > 160/95 and >140/90 mmHg) and four based on the total CV risk approach (10-year risk of a fatal or non-fatal major cardiovascular event: 40%, 30%, 20%, and 15%) in South Africa. The authors concluded that hypertension treatment based on the total CV risk is more effective at saving lives and less costly than those based only on the BP level [22]. Also, a study conducted in Seychelles [19] compared distinct risk management strategies for the prevention of cardiovascular events - single-risk factor management (high BP and/or high serum cholesterol), total CV risk management, and WHO guidelines. The number of subjects eligible for treatment is much lower when considering the total risk approach (total CV risk ≥ 10%) while averting a higher number of CV events than when treating subjects with BP ≥140/90 mmHg. Considering the WHO guidelines the number of subjects eligible for treatment (both with antihypertensive and/or lipid-lowering drugs) would be approximately twice higher than if treating those with total CV risk ≥10%, and the number of events prevented would be also higher (147 per 100 000 vs. 137 per 100 000 individuals aged 40-64 years) [19].

According to the WHO guidelines, about 20% of the Mozambican adults aged 40-64 years were eligible for pharmacological treatment of hypertension, corresponding to ≈ half million people. Treating all these subjects with hydrochlorothiazide (25mg) and amiloride (2.5mg), the first line of

pharmacological treatment recommended by the Mozambican guidelines for the diagnosis, treatment and control of hypertension [23] would correspond to an overall estimated annual cost of 0.8 million US dollars (USD), based on the costs of these medicines to the Mozambican Ministry of Health (personal communication). Assuming that 50% of these subjects would require additional treatment with a second line drug (*e.g.* amlodipine, 5 to 10mg [23]), and that 25% would also need a third line drug (*e.g.* atenolol, 50 to 100mg [23]), the overall estimated annual cost would be ≈ 11 million USD. After excluding HIV/AIDS, malaria, tuberculosis and contraceptive drugs, this corresponds to more than one-third of the remaining budget of the Mozambican Ministry of Health for medicines (personal communication). Although the accuracy of these values is limited by the fact that we have no empirical data to estimate the proportion of hypertensive subjects requiring second and third line therapies, these results show that the pharmacological treatment of hypertension according to the WHO guidelines would be difficult to afford in this setting. Furthermore, these figures underestimate the burden associated with hypertension because subjects aged below 40 and above 64 years were not considered in our analyses. Although the latter correspond to less than 5% of the population, there are 3.9 million Mozambicans aged 25-39 years, among whom the prevalence of systolic/diastolic BP ≥160/100 mmHg is 10.7% (prevalence observed in this STEPS survey among subjects that were not treated with anti-hypertensive drugs).

In addition to the financial resources necessary to cover the unmet needs regarding the pharmacological treatment of hypertension in Mozambique, it should be noted that a large proportion of the Mozambicans never had their BP measured (64% in our sample). Therefore, improving awareness is also a major challenge in this setting.

High and very high CV risk (≥20%) was more frequent in urban areas, in accordance with the higher mortality from CV diseases among urban dwellers [9], and reflects the urban/rural distribution of risk factors that underlie the construct of CV risk, since hypertension [5], diabetes [24], and manufactured cigarette smoking [25] are more common among urban Mozambicans.

The high proportion of population at low total CV risk (<10%) stresses the potential for reduction of CV risk through the implementation of public health policies to create supportive environments for quitting tobacco, eating healthy, and being physically active. Although these behaviors are influenced by economic growth and unplanned urbanization, it is feasible to implement multisectorial policies to counteract the adverse influences of the global environment. A set of measures namely for controlling tobacco use (*e.g.* raising taxes on tobacco products and taking into account the potential for transition from smokeless and traditional forms of tobacco consumption to manufactured cigarettes [26]), and improving diet (*e.g.* controlling salt intake,

enforcing farming production, namely fruit and vegetables, and promoting moderate alcohol intake in habitual drinkers), may contribute to decrease the exposure to the CV risk factors. Beyond those environmental supportive policies, monitoring their distribution and providing access to effective and comprehensive educational and public awareness programmes on the healthy behaviours, are key aspects to minimize CV diseases specially in a country with very low levels of awareness [5].

In conclusion, only half of the nearly 40% of Mozambicans aged 40-64 years with systolic/diastolic BP≥140/90 mmHg meet the eligibility criteria for pharmacological treatment according to the WHO guidelines. Taking into account the available evidence on the effectiveness of different approaches to manage hypertension at a population level, the substantial differences in the number of subjects eligible for treatment according to the distinct criteria suggests that considering the total CV risk may allow a more efficient use of the scarce resources available in developing settings.

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Paper VI

Padrão P, Severo M, Damasceno C, Silva-Matos C, Prista A, Azevedo A, Lunet N. Model-based patterns of cardiovascular risk factors in Mozambique [submitted for publication].

Model-based patterns of cardiovascular risk factors in Mozambique

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[Submitted for publication]

Abstract

Background: Risk factors for cardiovascular diseases tend to cluster, although evidence from settings under epidemiological transition is scarce.

Aim: To identify patterns of clustering of cardiovascular risk factors, and to quantify their association with sociodemographic characteristics, in Mozambique.

Subjects and methods: A national representative sample (n=3323) of subjects aged 25-64 years was evaluated in 2005, using the World Health Organization Stepwise Approach to Chronic Disease Risk Factor Surveillance (STEPS). Patterns of joint exposure to high blood pressure, high fasting blood glucose, high body mass index, smoking, excessive alcohol consumption, low fruit/vegetables intake, and insufficient physical activity were identified through latent class analysis.

Results: Three patterns were identified among women: 1) "healthier", lower frequency of most risk factors (53.0%); 2) "hypertension-overweight" (21.1%), more frequent among older and urban subjects; 3) "hypertension-smoking-alcohol" (25.9%), whose frequency increased with age and decreased with education. In men, two clusters were identified: 1) "hypertension-overweight" (30.1%); 2) "smoking" (69.9%). The frequency of the latter pattern was higher in urban areas and increased with age and education.

Conclusion: Hypertension, overweight/obesity, smoking and excessive alcohol intake defined the main clusters of cardiovascular risk factors. This should be considered when planning prevention and control strategies for cardiovascular diseases in Mozambique.

Keywords: cardiovascular diseases; risk factors; cluster analysis; Africa.

Introduction

Cardiovascular (CV) diseases are among the most important causes of death in the more developed settings, and are emerging as a new epidemic also in countries where communicable diseases remain a sizable problem (Institute for Health Metrics and Evaluation, 2013). Worldwide, the joint effects of four major lifestyle risk factors (tobacco use, insufficient physical activity, low fruit and vegetables intake, and excessive alcohol drinking), and intermediate risk factors [high blood pressure (BP), high blood cholesterol, and obesity], jointly explain approximately 80% and 70% of cases of ischemic heart disease and stroke, respectively (Ezzati et al., 2003).

In Mozambique, in 2006-2007 the main causes of death in the adult population were Human Immunodeficiency Virus Infection/Acquired Immunodeficiency Syndrome (HIV/AIDS) and Malaria, though morbidity and mortality from CV diseases, especially stroke, is becoming increasingly important, mainly in urban areas (Damasceno A. et al., 2010, Gomes et al., 2013). Previous analyses of data from nationwide surveys conducted in Mozambique showed gender and urban/rural differences (Padrão et al., 2013, Padrão et al., 2012) and local-specific patters of clustering of several risk factors. The relation between tobacco consumption and alcohol drinking or fruit and vegetables intake was not consistent for all forms of tobacco use (Padrão et al., 2011b) and less than 4% of the Mozambicans aged 40-64 had a 10-year risk of a major CV event ≥20% (Damasceno et al.) despite the high prevalence of hypertension (approximately one-third of the adult population (Damasceno et al., 2009). While the former example reflects the nature and joint distribution of the exposures in this setting, the total CV risk may be underestimated because the World Health Organization/International Society of Hypertension prediction charts (Mendis et al., 2007) do not take into account important risk factors, such as overweight/obesity or alcohol drinking. A comprehensive *a posteriori* analysis of the clustering of these exposures may provide valuable information to target the most important patterns of CV risk in Mozambique.

Thus, the aimed of this study was to identify patterns of clustering of CV risk factors (smoking, excessive alcohol drinking, low fruit and vegetables intake, insufficient physical activity, high BP, high body mass index, and high fasting blood glucose), and to quantify their association with sociodemographic characteristics (place of residence, age, and education), in the Mozambican adult population.

Methods

The present community-based cross-sectional study evaluated a representative sample of the Mozambican adults aged 25 to 64 years, in 2005, as previously described in detail (Damasceno et al., 2009).

Briefly, using a sampling frame derived from the 1997 Mozambican census (Instituto Nacional de Estatística, 1997) 95 geographical clusters were selected across 11 strata (provinces). In each cluster all the households were listed and 25 randomly selected and visited. In each household selected, all the subjects in the eligible age-range were invited to participate (n=3378); 55 refused and the remaining (98.4% of the invited) were evaluated at their homes by trained interviewers, following the WHO STEPwise approach to chronic disease risk factor surveillance (STEPS) (World Health Organization). This comprised a face-to-face interview using a structured questionnaire to collect information on sociodemographic characteristics, tobacco consumption (Padrão et al., 2013) drinking of alcoholic beverages (Padrão et al., 2011a) fruit and vegetables intake (Padrão et al., 2012) physical activity (Global Physical Activity Questionnaire) (Armstrong and Bull, 2006), and use of antihypertensive and antidiabetic drugs.

BP was measured on a single occasion by nonphysician trained interviewers using a semiautomatic sphygmomanometer (Omron 3®, OMRON Corporation, Kyoto, Japan) with an appropriate cuff size (Damasceno et al., 2009, World Health Organization, 2008). Weight was measured to the nearest 0.1 kg using a digital scale and height to the nearest 0.1 cm in the standing position using a portable stadiometer (World Health Organization, 2008). Twelve-hour fasting glucose (FBG) was obtained in accordance with WHO standardized fingertip prick tests, using calibrated blood glucose meters and reagent strips (Accu-Chek® Advantage meter, Roche Diagnostics Corporation, Indianopolis, U.S.A.) (World Health Organization, 2008).

Individuals who reported being smokers of any tobacco product at the time of the survey, daily or occasionally, were classified as smokers (Mackay and Eriksen, 2002).

Excessive alcohol drinking was defined according to the recommendations of the *American Heart Association* of a maximum daily intake of 1 standard drink for women and 2 for men (Lichtenstein et al., 2006).

Given the WHO recommendation of at least 5 daily servings of fruits and/or vegetables (Joint WHO/FAO Expert Consultation, 2003) and the absence of specific recommendations for each of these food groups, this study conservatively considered that the participants had low intake of each of them when reporting an intake below the cut-off of 2 servings/day for fruit or vegetables.

Insufficient physical activity was defined according to the new WHO global standard of at least 150 minutes/week of moderate-intensity aerobic physical activity, or at least 75 minutes/week

of vigorous-intensity aerobic physical activity, or an equivalent combination of moderate and vigorous intensity activity (World Health Organization, 2010).

The cutoffs of *The Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure* were used to group the participants according to their systolic/diastolic BP, as follows: <140/90 mmHg – normal/prehypertension; ≥140/90 mmHg and <160/100 mmHg – hypertension stage 1; ≥160/100 mmHg – hypertension stage 2 (National Institutes of Health and National Heart Lung and Blood Institute, 2004). Subjects reporting the use of antihypertensive drugs in the previous two weeks were considered to be treated pharmacologically for hypertension and were not further considered for data analysis (Figure 1).

Overweight and obesity were defined using the WHO cutoffs for Body Mass Index (BMI), as follows: <25.0 kg/m^2 - underweight/normal weight; ≥25.0 kg/m^2 and <30.0 kg/m^2 – overweight; ≥30.0 kg/m^2 – obesity (World Health Organization, 2000).

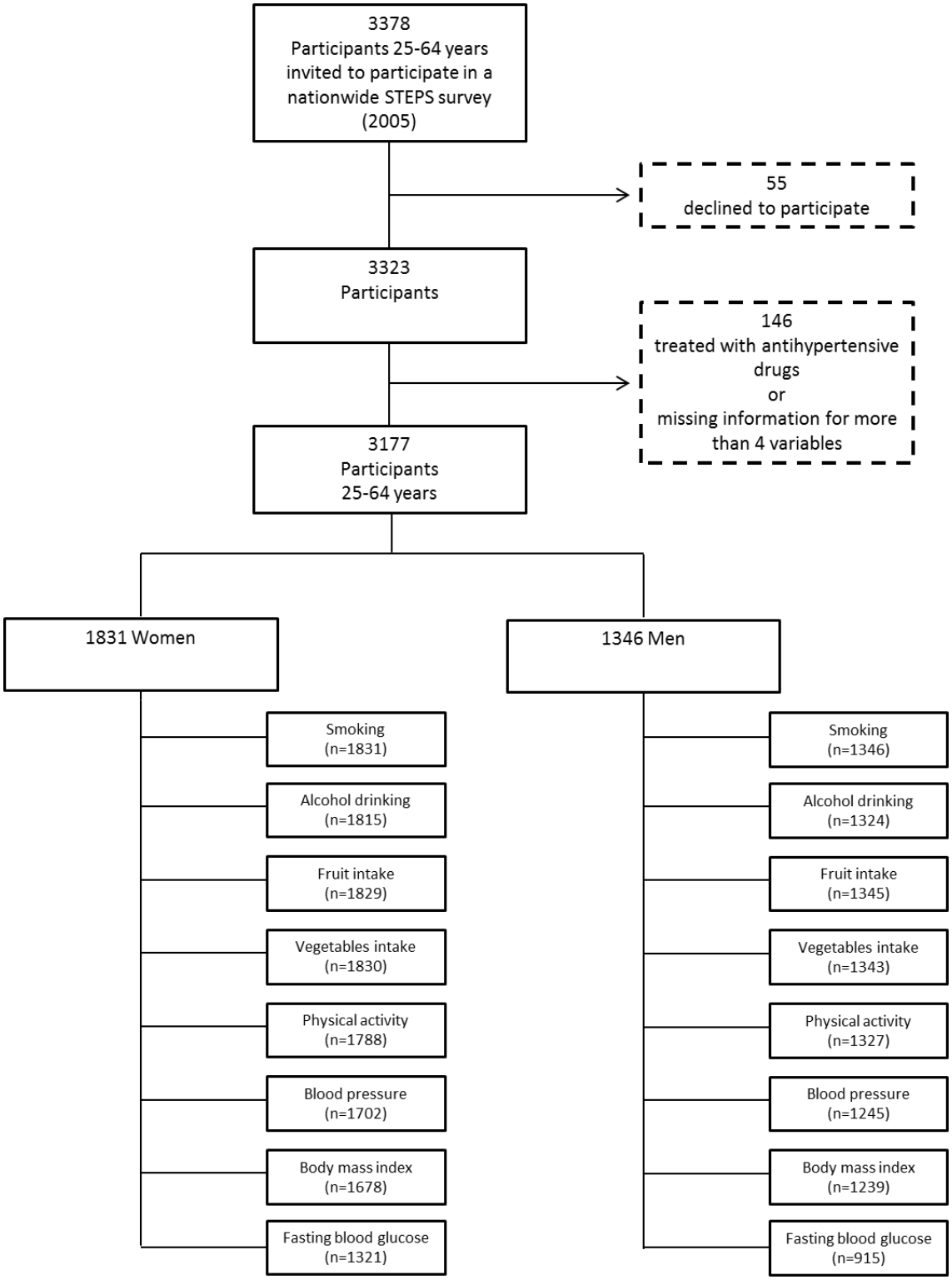
The WHO cutoffs were used to group the subjects according to their FBG, as follows: <5.6 mmol/L – normoglycaemia; ≥5.6 and <6.1 mmol/L - impaired fasting glucose; and ≥6.1 mmol/L – diabetes. Participants reporting to take insulin or oral antidiabetic drugs were also classified as having diabetes (Alberti and Zimmet, 1998).

Statistical analysis

Latent class analysis (LCA) is used to uncover distinct groups of individuals from a sample (clusters), homogeneous within the group, considering that the performance of an individual in a set of items is explained by a categorical latent variable with K classes, commonly called 'latent classes'. Interpretation of the model is usually based on item profiles in each category, obtained from the probabilities of endorsing each item response, conditional on class membership.

In this study, sex-specific LCA was used to define patterns of clustering of 8 CV factors, namely smoking, excessive alcohol drinking, low fruit and vegetables intake, insufficient physical activity, high BP, high body mass index, and high fasting blood glucose (Figure 1).

Figure 1. Flow-chart describing the selection of participants for the present study, and the number with information available regarding each of the exposures considered.



Sociodemographic characteristics known to be associated with the exposure to CV risk factors were used as concomitant variables, namely place of residence (urban/rural) (Instituto Nacional de Estatística, 1997), age (25-34, 35-44, 45-54, and 55-64 years), and education (<1, 1-5, and ≥6 schooling years). In LCA, concomitant variables are covariates considered in the process of formation of the latent classes, by the multinomial regression of latent classes on concomitant variables, to allow for different contributions of the items to define the classes for different levels of concomitants (Vermunt and Magidson, 2002).

All models were fitted using MPlus (V.5.2; Muthen & Muthen, Los Angeles, California, USA). LCA may converge on local maxima of the likelihood values; if the researcher simply selects a single start-value for the analysis, there is no way to determine whether the solution reflects such a local maxima, or if more-stable solutions might have been found with alternative start values. To overcome this potential limitation, 200 sets of random starting values for 10 iterations each were generated, and then ran the 30 best performing starting values to convergence. The number of clusters was defined according to the Bayesian information criterion (BIC); the best solution was identified when there was no decrease in BIC with the increase in the number of latent classes. The classification of the participants was based on their most likely latent class membership.

The counts and proportions for the latent classes and the odds ratios (OR) and 95% confidence intervals (95% CI) were presented for the association with the sociodemographic variables, based on the estimated model.

Ethics

The study protocol was approved by the National Mozambican Ethics Committee and written informed consent was obtained from all participants.

Results

The models with the best fit, *i.e.* lowest BIC (Table I), included risk factors and sociodemographic characteristics and yielded three clusters among women [median (range) latent class probabilities for most likely latent class membership: cluster 1, 92.2% (40.4%-99.6%); cluster 2, 81.5% (36.7%-99.9%); cluster 3, 83.7% (37.3%-99.9%)] and two clusters among men [cluster 1, 96.4% (50.2%-100.0%); cluster 2, 86.5% (50.4%-100.0%)].

Table I. Sex-specific latent class analysis for cardiovascular risk factors and sociodemographics as class determinants, in Mozambique.

Sex	No. of classes *	Cardiovascular risk factors†			Cardiovascular risk factors† and Sociodemographic‡ characteristics ¶		
		Log L	No. of parameters	BIC	Log L	No. of parameters	BIC
Women							
	1	**-6033.068**	**11**	**12148.828**	-6033.068	11	12148.828
	2	-6004.359	23	12181.621	-5806.275	26	11807.878
	3	-5980.467	35	12224.047	**-5709.695**	**41**	**11727.407**
	4	-5966.450	47	12236.224	-5661.039	56	11742.785
Men							
	1	-4830.337	11	9739.936	-4830.337	11	9739.936
	2	**-4783.764**	**23**	**9733.257**	**-4684.909**	**26**	**9561.146**
	3	-4767.400	35	9786.997	-4635.324	41	9566.048

* The bold font denotes the best models according to lowest BIC; † Smoking, high alcohol intake, overweight/obesity, high blood pressure, diabetes, insufficient physical activity, fruit and vegetables consumption; ‡ Place of residence, age and education; ¶ A putative role of concomitant variables only exists in models with at least two latent classes, in which concomitants can influence the classification in different groups.
BIC, Bayesian information criteria; Log L, log likelihood.

Among women, cluster 1 was characterized by the lowest prevalences of nearly all risk factors and was labeled “healthier”; it included more than half the sample. The prevalence of high BP was high in the other two clusters; approximately 50% of the women had systolic/diastolic BP>140/90 mmHg, though these could be distinguished by the levels of exposure to the remaining risk factors. While cluster 2 had the highest prevalences of

overweight/obesity (66.8%), IFG/diabetes (9.1%), insufficient physical activity (5.3%) and low vegetables intake (84.0%), cluster 3 was characterized by the highest prevalences of smoking (16.2%) and excessive alcohol intake (16.3%). Clusters 2 and 3 were labeled as "hypertension-overweight" and "hypertension-smoking-alcohol", respectively (Table II).

Table II. Prevalence of each risk factor by pattern of cardiovascular risk factor clustering in Mozambican women.

Risk factor	Total	Patterns of cardiovascular risk factors					
		Cluster 1 "Healthier" (53.0%)	Cluster 2 "Hypertension-overweight" (21.1%)	Cluster 3 "Hypertension-smoking-alcohol" (25.9%)	P ‡	P ¶	P §
Smoking (% current smokers)	6.6	3.0	3.1	16.2	0.074	0.004	0.052
Alcohol drinking (% excessive alcohol intake)	8.0	4.4	6.3	16.3	0.034	0.001	0.015
Body mass index (Kg/m^2)							
<25.0 (underweight/normal weight)	74.8	88.9	33.2	85.9			
25.0-29.9 (overweight)	15.9	9.1	36.3	10.3	0.015 ‖	0.066 ‖	0.022 ‖
≥30.0 (obesity)	9.3	2.1	30.5	3.8			
Blood pressure (systolic/diastolic, mmHg)							
<140/90 (normal/prehypertension)	68.1	89.3	46.2	48.3			
≥140/90 and <160/100 (HT stage 1)	18.4	9.5	30.4	24.5	0.005 #	<0.001 #	0.010 #
≥160/100 (HT stage 2)	13.5	1.2	23.4	27.3			
Fasting blood glucose (mmol/L)							
<5.6 (normoglycaemia)	95.3	97.3	90.9	95.8			
≥ 5.6 and <6.1 (IFG)	2.6	1.7	4.1	2.8	0.017 **	0.064 **	0.031 **
≥ 6.1 (diabetes)	2.1	1.0	5.0	1.4			
Insufficient physical activity *	2.7	2.3	5.3	1.2	0.034	0.223	0.248
Low fruit intake †	81.8	80.0	80.1	86.6	<0.001	<0.001	<0.001
Low vegetables intake †	76.2	77.4	84.0	67.3	0.001	<0.001	0.001

* Not meeting World Health Organization recommendations; † Lower than two daily servings; ‡ cluster 1 vs. cluster 2; ¶ cluster 1 vs. cluster 3; § cluster 2 vs. cluster 3; ‖ P values for the comparison of body mass index ≥25 vs <25 Kg/m^2; # P values for the comparison of blood pressure ≥140/90 vs. <140/90 mmHg; ** P values for the comparison of fasting blood glucose ≥ 5.6 vs. <5.6 mmol/L; HT, Hypertension; IFG, Impaired Fasting Glucose.

Compared to cluster 1, the frequency of the other patterns increased with age, cluster 2 was much more frequent in urban dwellers, and cluster 3 was inversely associated with education (Table IV).

In men, cluster 1 membership was the most likely for more than two-thirds of the sample; it was characterized by a high prevalence of smoking and was therefore labeled as "smoking". Cluster 2 included participants with a higher frequency of the remaining risk factors, though differences were more pronounced for overweight and stage 2 hypertension; it was labeled "hypertension-overweight" (Table III). The "smoking" pattern was much more likely in urban dwellers, and older and more educated subjects (Table IV).

Table III. Prevalence of each risk factor by pattern of cardiovascular risk factor clustering in Mozambican men.

Risk factor	Total	Patterns of cardiovascular risk factors		
		Cluster 1 "Smoking" (69.9%)	Cluster 2 "Hypertension-overweight" (30.1%)	P ‡
Smoking (% current smokers)	36.5	47.4	13.6	0.003
Alcohol drinking (% excessive alcohol intake)	14.1	11.6	19.3	<0.001
Body mass index (Kg/m^2)				
<25.0 (underweight/normal weight)	87.2	96.7	67.4	
25.0-29.9 (overweight)	10.0	3.0	24.4	0.020 ¶
≥30.0 (obesity)	2.8	0.3	8.1	
Blood pressure (systolic/diastolic, mmHg)				
<140/90 (normal/prehypertension)	62.1	67.0	51.9	
≥140/90 and <160/100 (HT stage 1)	23.6	23.5	23.9	
≥160/100 (HT stage 2)	14.3	9.5	24.2	0.004 §
Fasting blood glucose (mmol/L)				
<5.6 (normoglycaemia)	92.9	95.1	88.7	
≥ 5.6 and <6.1 (IFG)	3.3	2.6	4.6	0.009 ‖
≥ 6.1 (diabetes)	3.8	2.4	6.6	
Insufficient physical activity *	2.5	1.0	5.6	0.087
Low fruit intake †	81.9	82.8	80.0	<0.001
Low vegetables intake †	81.7	76.3	92.9	0.002

* Not meeting World Health Organization recommendations; † Lower than two daily servings; ‡ Cluster 1 vs. cluster 2; ¶ P values for the comparison of body mass index ≥25 vs <25 Kg/m^2; § P values for the comparison of blood pressure ≥160/100 vs. <160/100 mmHg; ‖ P values for the comparison of fasting blood glucose ≥ 5.6 vs. <5.6 mmol/L; HT, Hypertension; IFG, Impaired Fasting Glucose.

Table IV. Odds ratios for the association between sociodemographics and patterns of cardiovascular risk factors in Mozambique.

	Women			Men	
	Cluster 1 "Healthier"	Cluster 2 "Hypertension-overweight"	Cluster 3 Hypertension-smoking-alcohol"	Cluster 1 "Hypertension-overweight"	Cluster 2 "Smoking"
	Reference	OR (95%CI)*	OR (95%CI)*	Reference	OR (95%CI)*
Place of residence					
Urban vs. rural	1	25.05 (5.15-121.84)	1.01 (0.27-3.77)	1	7.38 (1.85-29.39)
Age					
10-year increase	1	6.34 (3.52-11.44)	9.75 (4.57-20.81)	1	2.89 (1.40-5.97)
Education					
One-year increase	1	1.09 (0.91-1.29)	0.59 (0.43-0.80)	1	2.00 (1.53-2.62)

* Estimated by latent class analysis.
OR, odds ratio; 95%CI, 95% confidence interval.

When considering only the participants with a class membership probability higher than 90% the main characteristics of the clusters remained essentially the same, and the differences between groups were even more pronounced (data not shown). Sensitivity analyses also conducted considering only the participants with complete information for all risk factors, and the conclusions remained unchanged (data not shown).

Discussion

Sex-specific patterns of CV risk factors were identified in the Mozambican adult population, defined mostly by hypertension, overweight/obesity, smoking, and excessive alcohol intake.

Several studies have described the clustering of CV risk factors, although the direct comparison of the results is difficult due to the use of diverse classification criteria, and the heterogeneity in the type and number of exposures considered, as well as regarding the age groups and populations evaluated.

Compared to traditional approaches for assessing the aggregation of risk factors, LCA has some advantages namely the probability-based classification (subjects are classified into clusters based upon membership probabilities estimated directly from the model), variables may be continuous or categorical, and demographics and other covariates can be used for cluster description (Magidson and Vermunt, 2005).

Hwang and Lee (Hwang and Lee, 2005) used LCA to identify profiles of CV risk factors (including high BMI, FBG, blood cholesterol and BP, excessive alcohol drinking, smoking, low physical activity, and emotional stress), among industrial workers from Korea and identified four clusters, two of them were classified as high risk subjects (both had increased probability of high BMI, blood cholesterol, BP and excessive alcohol consumption; one of them had in addition high probability of smoking), one at mild risk (high BMI and blood cholesterol, excessive alcohol consumption and smoking), and one was considered to be "normal", with low prevalences of the factors analyzed.

In the Netherlands, de Vries et al (de Vries et al., 2008) identified three clusters of lifestyle behaviors (excessive alcohol consumption, smoking, insufficient physical activity, and low fruit and vegetable intake) also using LCA: the "healthy" (low probabilities for the five lifestyle behaviors), the "unhealthy" (high probabilities for the five lifestyle behaviors), and the "poor nutrition" (insufficient physical activity, smoking, excessive alcohol consumption, low fruit and vegetable consumption) clusters. In an African American adult population, Baruth *et al* (Baruth et al., 2011) described the following aggregation of metabolic CV risk factors obesity and hypertension (18%); obesity, hypertension, and hypercholesterolemia (13%); obesity, hypertension, hypercholesterolemia, and diabetes (10%).

In Africa several studies reported on the prevalence of both individual and multiple CV risk factors (Pisa et al., 2012, Charlton et al., 2001, Oladapo et al., 2010), but only a few addressed the patterns of clustering. Ogunleye *et al* assessed the co-ocurrence of metabolic risk factors in a rural community from Nigeria (Ogunleye et al., 2012), and found that

hypertension and dyslipidemia was the most prevalent cluster. In Senegal, Pessinaba *et al* reported that hypertension was significantly associated with dyslipidemia, obesity and low physical activity (Pessinaba et al., 2013) while in Tanzania, it was reported that BMI was significantly correlated with BP, both in women and men, but also with triglycerides, cholesterol, and FBG, only in men (Njelekela et al., 2009).

In the present study, nearly half of the women were classified in the "healthier" cluster while the remaining, older than the former, had high probability for hypertension concomitantly either with overweight/obesity (prevailing in urban areas) or with smoking and excessive alcohol drinking (more frequently among less educated), suggesting two distinct pathways for high BP; the possibility of a different etiology for these clusters may have implications on the strategies of prevention and control. Regarding men, more than two-thirds were allocated to the "smoking" cluster, with predominance of older and more educated subjects and urban dwellers. This finding is more difficult to understand given the heterogeneity of the smoking pattern in Mozambique. Smoking of hand-rolled cigarettes which prevails in rural areas and tends to be more frequent among older less educated men, coexists with manufactured cigarette smoking, which is more common among less educated men, especially from urban areas. The confluence of the characteristics of each group of smokers, along with a tendency for a higher prevalence of hypertension among less educated men contributes to understand the role of sociodemographic characteristics in the definition of membership to the of the male "smoking" pattern.

This study was based on a large representative sample of the adult Mozambican population, and to our knowledge is the first report addressing the clustering of multiple cardiovascular risk factors in a sub-Saharan African country. However, some limitations need to be addressed.

The very high prevalence of low intake of fruit and vegetables, as well as the very low prevalence of insufficient physical activity and diabetes in the Mozambican population, may have reduced the discriminative capacity of these factors, despite significant differences were observed in their distribution across the main clusters. Although dyslipidemia was not considered in the present study, due to the lack of valid data for Mozambique, the prevalence of this risk factor in the Mozambican setting is expectedly low and no major contribution could be expected from this variable to the definition of the main patterns.

BP was measured on a single occasion, which may have contributed to an overestimation of BP (Pereira M. et al., 2010), and misclassification of the probability of class membership for each subject. However, no important differences are expected in the characteristics of the main clusters defined in this study.

Taken together, the results of the present study reflect that the position of the Mozambican population in the stages of epidemiological transition differ between urban and rural areas given the high proportion of the urban population endorsed to clusters of unhealthier patterns, thus suggesting that urban areas are moving ahead of rural areas.

These findings highlight the possibility of integrated approaches addressing multiple risk factors in primary care having a higher impact than single-behavior interventions (Prochaska et al., 2008), besides the lower costs involved, which is of major relevance in low resource settings.

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Paper VII

Silva V, Santos S, Novela C, Padrão P, Moreira P, Lunet N, Damasceno A. Some Observations on Food Consumption and Culinary Practices in Maputo, Mozambique. *In* Rodrigues S, Marques HÁ, Franchini B, Dias D, (Editors). Culinary Arts and Sciences VIII. Global, Local and National Perspectives. 2013, Association of Portuguese Nutritionists, Porto, Portugal, pp.93-98. ISBN: 978-989-8631-08-4.

Some observations on food consumption and culinary practices in Maputo, Mozambique

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Keywords: food habits, culinary practices, traditional foods, unprocessed/minimally processed food, processed ingredients, ultra-processed food products, Mozambique, Maputo

Abstract

Aim: To describe food consumption and culinary practices in adults from Maputo. **Methods**: The present study was based on a cross-sectional evaluation of a convenience sample of adults from Maputo city. Dietary intake was assessed through 24h dietary recalls applied to 50 dwellers, and foods were classified according to the extent and purpose of their processing, according to the classification proposed by Monteiro *et al*. **Results**: The most frequently reported foods were rice (90%), bread (80%), and vegetables (76%); the medians of consumption among consumers were 107 g, 150 g and 60 g, respectively. Fourteen percent of the sample met the recommended intake of 400 g of fruit and vegetables. Traditional dishes and fast food were consumed by 46% and 4% of the participants, respectively, while chicken powdered stocks and salt added in food preparation were reported by 70% and 94% of the participants, respectively. Sugar sweetened beverages were consumed by 54% of the respondents (median=500 ml). All the respondents reported the consumption of unprocessed/minimally processed foods (median=1073 g) and processed ingredients (median=35 g), while 92% consumed ultra-processed food products (median=478 g). **Conclusion**: Although traditional food practices are still rooted among adults from Maputo, the high consumption of processed ingredients and ultra-processed food products namely chicken powdered stocks and sugar sweetened beverages suggests the effects of globalization on food habits.

Introduction

Mozambique is one of the poorest countries in the world, and it is estimated that one-third of the 23 million inhabitants live in urban areas, including the capital Maputo with 1.1 million of dwellers[1]. While there has been significant economic growth in recent years, a high proportion of the population still lives with less than $1/day[1],

which necessarily contributes to shape the population's dietary habits. On the other hand, global influences are expected to increasingly contribute to changes in the availability and consumption of foods[2-4]. We report on food consumption and culinary practices of adults living in the city of Maputo, Mozambique.

Methods

This study was based on a cross-sectional evaluation of a convenience sample of the adult general population from city of Maputo (n=50). Participants belonged to different households and were interviewed in 2012/2013.
A trained interviewer collected food intake data using a single 24-hour dietary recall. Participants were asked to report all foods and beverages consumed during the previous 24 hours. They were prompted to say the type and amount of added fat, sugar, salt and other seasonings, the brand of the processed foods and the name of the dishes. Details about the method of culinary preparation, amount consumed, recipes and foods eaten outside of the home were also reported. Portion sizes were assessed using a quantification album with pictures of common household measures, such as spoons, plates, cups and glasses. Culinary practices were also assessed and quantified. All subjects gave their consent before participating in the survey.
The criteria defined by Monteiro *et al*[5] were used to classify foods according to the extent and purpose of their processing, into three groups: unprocessed/minimally processed foods; processed ingredients; ultra-processed food products.
Prevalence estimates, and median (percentile 25-percentile 75) among consumers, were computed for each food/food groups in the previous 24 hours.

Results

The sample included 50 adults (31 women and 19 men), aged between 25 and 62 years (median: 41 years; 18% aged above 50 years); 62% had less than 5 schooling years and 26% completed the secondary school. The frequency and amount of each food/food groups and beverages consumed is shown in Table 1. All the respondents reported the intake of unprocessed/minimally processed foods (median=1073 g), and processed ingredients (median=35 g). The consumption of ultra-processed food products was reported by 92% of the participants (median=478 g).
The most frequently consumed foods in the previous 24 hours were rice (90%), bread (80%) and vegetables (76%), with a median intake of 107g, 150g, and 60g, respectively. Approximately half of the participants reported the consumption of meat, fish (the median of both was 125 g), and sugar sweetened beverages (median=500ml). Fourteen percent of the sample met the recommended intake of 400 g of fruit and vegetables. Almost half of the respondents reported the intake of peanuts (median=68 g) and coconut (median=125 g) in culinary preparations, as well as the consumption of edible leaves (median=63 g), including cabbage, pumpkin, cassava, cowpea and *cacana* leaves. Only two participants reported to have consumed alcoholic beverages (median=1663 ml).
All participants used culinary herbs, lemon, garlic, tomato or onion as seasoning, and 94% added salt in food preparation. Powdered chicken stock with high sodium content

was used by 70%, during or after culinary preparation and 4% used powdered soups. Almost all participants (94%) that reported to eat salad added salt as a seasoning. Fast food and regional typical dishes were reported by 4% and 46% of the participants, respectively. The typical dishes included: *mboa* (pumpkin leaves with peanuts and coconut milk); *chima/xima* (cornflour cooked with water); *nhangana* (cowpea leaves with peanuts and coconut milk); *couve* (cabbage with peanuts and coconut milk); *chamuça de peixe* (fish samosa); *badjias de feijão nhemba* (fried salty snack made with cowpea beans); *cacana* (cacana leaves with peanuts and coconut milk); peanut curry (peanut stew with or without meat); and *matapa* (cassava leaves with peanuts and coconut milk). The most frequently reported nontraditional dishes were: *feijoada* (stew with butter beans with/without meat); salad (with a lettuce or cabbage base, sometimes with tomato and/or cucumber); stewed (stewed mackerel with onion and tomato) and fried fish (mackerel sprinkled with flour).
Major culinary practices, were: stewing (52% reported twice a day), frying (38% reported once a day), and boiling (38% reported once a day). The consumption of grilled and roasted foods was much less frequent (4% and 2% of the participants reported to eat grilled and roasted foods once a day, respectively).

Discussion

The consumption of unprocessed/minimally processed foods, particularly rice and vegetables were the most frequently consumed foods in this sample of Maputo inhabitants although processed ingredients such as chicken powdered stocks were massively used. The consumption of fruit and vegetables was much below the recommended 5 portions per day. Two-thirds of the sample reported the consumption of traditional dishes while sugar sweetened beverages were consumed by more than half of the participants.

Table1. Consumption of foods and beverages in the previous 24 hours

Foods and beverages	%	N	Median (percentile 25-percentile 75) (g/ml*)
Rice	90	45	107 (107-187)
Breads (all types)	80	40	150 (150-300)
Wheat bread	78	39	150 (150-300)
Whole Wheat bread	2	1	100 (100-100)
Pasta	22	11	88 (44-88)
Potato	22	11	125 (60-300)
Corn flour/corncob	18	9	63 (63-125)
Sweet Potato	8	4	120 (120-210)
Cassava	4	2	375 (250)
Milk (all types)	28	14	47 (30-294)
Powdered Milk	14	7	33 (22-33)
Fresh Milk	12	6	296 (181-423)*
Condensed Milk	2	1	8 (8-8)
Cheese	6	3	20 (20-20)

Foods and beverages	%	N	Median (percentile 25-percentile 75) (g/ml*)
Vegetables (except leaves)	76	38	60 (23-129)
Fruit	40	20	256 (131-405)
Leaves	42	21	63 (42-94)
Beans	36	18	94 (63-156)
Nuts (peanuts, cashews)	14	7	73 (49-146)
Peanuts (in culinary preparation)	46	23	68 (51-101)
Coconut (in culinary preparation)	46	23	125 (119-250)
Vegetable oil	90	45	8 (5-14)*
Margarine	30	15	5 (2-14)
Olive Oil	8	4	4 (2-5)*
Butter	4	2	2 (2-2)
Eggs	32	16	55 (55-55)
Fish	50	25	125 (63-125)
Crab and Dry Shrimp	4	2	86 (16)
Meat	54	27	125 (94-250)
Poultry (Chicken, Turkey)	36	18	125 (86-250)
Beef	28	14	125 (56-250)
Pork	4	2	116 (31)
Processed meats (e.g. sausages)	6	3	50 (47)
Pastry, cookies, jams, ice-cream, instant porridges	32	16	113 (57-160)
Sugar sweetened beverages	54	27	500 (300-600)*
Sugar	76	38	12 (8-24)
Tea	68	34	280 (280-560)*
Instant Coffee	10	5	232 (71-420)*
Alcoholic beverages	4	2	1663 (325)*
Unprocessed/minimally processed foods	100	50	1073 (755-1379)
Processed ingredients	100	50	35 (14-100)
Ultra-processed food products	92	46	478 (201-770)

The robustness of our finding is limited by the small sample size and the fact we evaluated a convenience sample. The participants were older and had higher level of education than the general Mozambican adult population, and therefore our results cannot be extrapolated to the whole country.

Despite these limitations, to our knowledge this study provides the first characterization of food consumption and culinary practices in Mozambique. It is documented that the major staple foods in Mozambique are rice, wheat, cassava, maize and millet but the importance of each one varies from region to region[1]. In urban south regions, as Maputo, the higher percentage of consumption of starchy foods refers to wheat (bread) and rice[1], which is in accordance with our findings and the changes observed in the consumption of cereals in West Africa in the last years, from locally produced grains (millet and sorghum) to imported wheat and rice[6].

Compared to vegetable foods, animal source foods were less frequently consumed. Although the production of animal foods is rising all around the world, this is not happening in the poorest African countries, resulting in low availability and high

prices[7]. According to data from the Food and Agriculture Organization, Mozambique is one of the countries with lowest consumptions of animal foods worldwide[7]. However, beans, nuts and edible leaves, which are more easily available to Mozambicans, can be considered important and cheaper alternative sources of protein.
The proportion of participants meeting the minimum recommended daily intake of 400 g of fruit and vegetables was slightly higher than the previous findings from a representative sample of Mozambican adults[8], which may be partially due to the difference in the methods used to assess fruit and vegetable intake. The prevalence of alcoholic beverages consumption was very low, in contrast to the results of a previous study that described alcohol consumption patterns in Mozambican adults[9]. However, in the latter report, drinking peaked at weekends and in the present study most of the 24h recalls (96%) were applied between Tuesday and Friday, which may contribute to explain the lower prevalence of alcohol consumption in our sample, despite the median intake was high.
The economic and social development of Mozambique along with the increasing urban global context of Maputo city, are driving the changes in dietary patterns in this setting. Although Mozambique is considered to be in the early stage of nutrition transition[10], as reflected in the predominant intake of unprocessed/minimally processed foods and traditional dishes, it is already visible a high demand for ultra-processed food products, readily available at cheap prices, by the majority of the population. The consumption of palatable foods such as sugary products, particularly sugar sweetened beverages, but also the widely use of salty processed ingredients particularly the powdered chicken stocks in the preparation of all types of foods, is a clear sign of change that deserves close monitoring.

Conclusions

This assessment of food consumption in a small sample of Maputo inhabitants shows that although traditional dishes are still well rooted in this sample of Maputo dwellers, the high consumption of ultra-processed food products and processed ingredients, such as sugar sweetened beverages and chicken powdered stocks, reflects the transition, from traditional to contemporary patterns of eating. There is room to promote better eating habits, anticipating the possible negative effects of globalization, in order to prevent the expected growth of nutrition-related noncommunicable diseases in this setting.

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Paper VIII

Silva V, Padrão P, Novela C, Damasceno A, Pinho O, Moreira P, Lunet N. Sodium content of bread from bakeries and traditional markets in Maputo, Mozambique [submitted for publication].

Sodium content of bread from bakeries and traditional markets in Maputo, Mozambique

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[Submitted for publication]

Abstract

Objective: The sodium content of bread is one of the most common targets of initiatives to reduce sodium intake worldwide. Assessing sodium content of staple foods is of major relevance in Mozambique, given the high burden of hypertension in this setting. We aimed to estimate the sodium content of white bread available in different selling points in Maputo, Mozambique.

Design: A cross-sectional study of the sodium content of white breads available for sale at 25 bakeries and markets in Mozambique. Flame photometry was used to quantify the sodium content of bread. The percentage of samples meeting manufacturer sodium targets from South Africa and six countries from other regions, selected as benchmarks, was computed.

Setting: Maputo, Mozambique

Subjects: Three white breads from each of the selected bakeries and markets.

Results: The mean sodium content of bread was 450.3 mg/100g (range: 254.9 to 638.3 mg/100g), with no significant differences between bakeries and traditional markets. Most samples (88%) did not meet the regulation in South Africa (≤380 mg/100g). When considering the targets from other countries (range: ≤360-550 mg/100g), the prevalence of non-accomplishment varied between 8% and 92%.

Conclusions: The content of sodium in bread varies widely in Mozambique, reaching high values in a high proportion of the selling points in Maputo. Measures to regulate the sodium content in bread may contribute to reduce sodium intake and improve health at a population level.

Keywords: sodium; bread; Mozambique; Africa.

Introduction

High sodium intake is strongly associated with high blood pressure[1] and stroke, being responsible for an estimated 4.0 million deaths worldwide in 2010[2]. The World Health Organization recommends no more than two grams of sodium per day [equivalent to five grams of salt (sodium chloride)/day] in adults, in order to reduce the burden of non-communicable diseases[3]. However, in all countries with recent data available the dietary sodium intakes are much higher than recommended[4]. To our knowledge, no such data from Mozambican populations has been published, despite sodium intake being of major relevance in this setting, given the high prevalence of hypertension (25-64 years: 33.1% in 2005), the low proportion of hypertensive subjects under pharmacological treatment (39.9% from the 14.8% who were aware of their condition)[5; 6] and the increasing public health impact of cardiovascular diseases (CVD). It is estimated that the number of deaths due to CVD almost doubled in Mozambique in the last decades (from nearly nine thousand in 1990 to almost 17 thousand in 2010)[7]. In 2005-2006, among subjects aged ≥25 years the incidence of stroke hospitalization in Maputo was estimated to be one of the highest in developing settings (adjusted incidence rates, world standard population: 260.1 per 100,000) [8], and the early case-fatality rates were also high [9].

Although the sources of sodium differ across high and low income countries, bread appears to be one of the most important contributors to the overall sodium intake worldwide[10]. In Mozambique, starch suppliers are the major staple foods; the consumption of cassava and maize prevails in the north of the country and bread intake is higher in the south [11; 12], being sold in bakeries and traditional markets (both formal and informal street markets). Data from the last Household Budget Survey showed that in Maputo city the daily per capita availability of bread was 106 g [13].

There are no manufacturer sodium targets for bread in Mozambique but in the neighbouring South Africa the Government has regulated the sodium content of processed foods, including bread, by stipulating a target of 380 mg/100g for the maximum sodium content of bread to be effective in June 2019[14]. For other countries worldwide, the targets range from 360 mg/100 g and 550 mg/100 g.

This study aimed to estimate the sodium content of white bread available in different selling points in Maputo, Mozambique, including bakeries and traditional markets.

Experimental Methods

Selection of the selling points and collection of samples

All the bakeries (n=16) from Maputo city listed in the Mozambican yellow pages[15] were identified, as well as the major traditional markets in the same urban area, including officially organized retail outlets confined to an area fitted for the purpose (formal traditional markets, n=3) and non-organized street markets (informal traditional markets, n=5). Additionally, a well-known bakery chain with four retail stores was identified and their head office bakery was included in the sample of selling points, increasing to 17 the number of bakeries visited.

Three white breads (breads made from wheat flour from which the darker coarser bran have been removed, remaining the starchy endosperm[16]), were bought in June 2012, in each of the 25 points of sale, and their prices were noted. Only one type of bread (white bread) was available in the selected selling points.

Each group of three breads was then weighed, packed in proper cooler bags (one bag for each point of sale) and frozen at -18 °C until sodium content analysis.

Sodium determination

After defrost at room temperature, the groups of three breads from each selling point were weighed and grinded mechanically for homogenization of each sample. After homogenization, three aliquots, with approximately two grams each, were collected and prepared for sodium determination, according to a previously validated method, described in detail elsewhere[17]. Briefly, the sodium existing in the bread is dissolved in doubly deionized water and quantified by flame photometry (flame photometer model PFP7, JenWay®, England).

Two readings of each of the three aliquots from the same homogenized bread sample were made. The variation between each group of six results was lower than 5%, and therefore the mean of the six results obtained was considered for data analysis. The final sodium content per 100 g of bread was adjusted for the difference between the weight of breads between the day of purchase and the date of analysis, as follows: final sodium content = (weight of bread at purchase * sodium content)/ weight of bread at analysis.

Non-accomplishment of the recommendations of the level of sodium in bread

In Mozambique there are no specific guidelines for the maximum sodium contents of bread, and therefore our results were interpreted according to the maximum levels allowed or recommended in countries where those guidelines exist, including the neighbouring South Africa and countries from other world regions, namely Australia, Finland, New Zealand, Portugal, United Kingdom, and United States (please see Table 1 footnotes for a more detailed description).

Statistical Analysis

The samples collected in bakeries and traditional markets were compared regarding the distribution of price (Mann-Whitney U-test) and sodium content (T-test for independent samples) of bread, and prevalence of non-accomplishment of the manufacturer sodium targets established by different countries, using the Chi-square test. A P value <0.05 was considered significant.

Results

Overall, the price per 100 g of bread varied between 2.2 and 6.2 *Meticais* (between 0.08 and 0.22 USD), being the median price 3.5 *Meticais,* with no significant differences between the breads available in bakeries and traditional markets (3.2 vs. 3.6 *Meticais*, P=0.288). The mean sodium content of bread was 450.3 mg/100 g, ranging between 254.9 mg/100 g and 638.3 mg/100 g, with no significant differences between bakeries and traditional markets (Table 1).

A total of 88% of the samples did not comply with the target defined in South Africa (≤380 mg/100 g), and 84% were above the maximum level of sodium in bread recommended in Australia (400 mg/100 g), and the United Kingdom (400 mg/100 g). Nearly half (56%) overcame the threshold recommended in New Zealand (450 mg/100 g), whereas only 8% exceeded the less restrictive limit imposed by the Portuguese Government (550 mg/100 g). The sodium content of nearly all samples (23 out of 25) did not comply with the target recommended in the United States (360 mg/100 g), and did not meet the requirement for a "reduced salt" label (360 mg/100 g) in Finland. Seven (out of 25) selling points had bread with a sodium content that exceed the threshold above which a "highly salty" label is required, according to the Finish guidelines (480 mg/100 g) (Table 1).

There were no statistically significant differences regarding the price of breads with a sodium content below and above the targets defined internationally (e.g. South African target, median price/100 g: 3.1 *meticais* (low sodium) vs. 3.5 *meticais* (high sodium), P=0.742; Portuguese target, median price/100 g: 3.4 *meticais* (low sodium) vs. 4.2 *meticais* (high sodium), P=0.355).

129 Table 1. Sodium content of white bread samples from Maputo city, Mozambique.

	Points of sale of bread			
	All (n=25)	Bakeries (n=17)	Traditional markets (n=8)	P
Sodium content (mg/100g)				
Mean (standard deviation)	450.3 (78.3)	448.5 (80.8)	454.1 (78.0)	0.872 [a]
Range	254.9-638.3	254.9-563.6	384.1-638.3	
n (%) >360 mg/100g [b]	23 (92)	15 (88)	8 (100)	0.453 [c]
n (%) >380 mg/100g [d]	22 (88)	14 (82)	8 (100)	0.296 [c]
n (%) >400 mg/100g [e]	21 (84)	14 (82)	7 (88)	0.618 [c]
n (%) >450 mg/100g [f]	14 (56)	12 (71)	2 (25)	0.043 [c]
n (%) >480 mg/100g [g]	7 (28)	6 (35)	1 (13)	0.246 [c]
n (%) >550 mg/100g [h]	2 (8)	1 (6)	1 (13)	0.547 [c]

130 [a] The T-test for independent samples was used for the comparison of bakeries and traditional markets.
131 [b] Defined according to the maximum level of sodium to be allowed by the Finish Government the reduced salt label in
132 bread[24] and the USA target of sodium content in bread for 2014[21].
133 [c] The Chi-square test was used for the comparison of bakeries and traditional markets.
134 [d] Defined according to the maximum level of sodium in bread established by the South African Government (to be
135 effective in June 2019)[14].
136 [e] Defined according to the maximum level of sodium in bread recommended by the Government from Australia[19] and
137 United Kingdom[25].
138 [f] Defined according to the maximum level of sodium in bread recommended by the National Heart Foundation of New
139 Zealand[19].
140 [g] Defined according to the level of sodium from which is required by the Finish Government the designation “highly salty”
141 in the label[24].
142 [h] Defined according to the maximum level of sodium in bread established by the Portuguese Government[26].

Discussion

The mean sodium content of bread available for purchase in the most important selling points in Maputo was 450 mg/100 g. Despite the wide range of values observed (254.9-638.3 mg/100 g), most samples (88%) were above the maximum levels recommended in the neighbouring South Africa.

Taking into account recent reports on this topic, the mean sodium content of bread was 544 mg/100g (range: 204 to 720 mg/100g) in a study from Nigeria[18] published in 2013, which is approximately 20% higher than the observed in our survey. On the other hand, the mean sodium level in bread samples collected in Maputo was similar to the reported in 2010 in Australia (427 mg/100 g) and New Zealand (463 mg/100 g)[19], and 12% higher than the described in 2009 in the UK (397 mg/100 g)[20]. These countries have achieved significant reductions in sodium content of bread along with important local efforts. In addition to national actions, broader initiatives such as those developed under the *European Union Framework for National Salt Initiatives* and the *World Action on Salt and Health,* may be contributing to reductions in the sodium content of bread. The *National Salt Reduction Initiative* from the USA is also committed to a progressive reduction of the sodium intake at a population level; the ambitious target of 360 mg of sodium per 100 g of bread was set to be achieved until 2014[21].

Breads sold in bakeries were produced on site, while those sold in the markets were probably purchased in bakeries which may help to explain the absence of significant differences in the sodium content of bread from bakeries and traditional markets. Nevertheless, we considered that it was important to include traditional markets in our sample of points of sale because they may have a relevant contribution in sales of bread in Maputo.

The high prevalence of iodine deficiency in Mozambique which is preventable by the use of iodized salt could be an argument against the reduction of salt intake. However, salt reduction and salt iodization are compatible[3; 22], as long as an appropriate monitoring of salt intake at country level is carried out in order to adjust salt iodization over time.

The selection of all bakeries registered at the yellow pages, as well as all the well-known formal and informal traditional markets, is expected to include the most of the more popular points of sale geographically scattered in Maputo, although some of the smaller bakeries and transient informal markets may have been missed. Also, our findings cannot be extrapolated to the whole country. An additional limitation of our study, is the fact that the results are not based on sales data, and therefore do not provide direct evidence on the actual sodium ingested from bread in Maputo.

Further research is needed to assess the overall sodium intake and the sources of sodium in the Mozambican population in order to prioritize the interventions needed to reduce the impact of the expected shift towards a more “industrialized” food pattern. Nevertheless, our results show that in this setting the efforts to reduce sodium intake may benefit from measures to regulate its content in bread, in addition to consumer education strategies. A partnership between the government, retailers and

manufacturers could be a step towards the reformulation of processed foods in order to decrease its sodium content. It would be also important to invest in strategies to overcome technical issues that arise when reducing sodium in processed foods, and to ensure the acceptability of the reduced sodium content foods by the consumers. The stepwise reduction of the foods' sodium contents is an affordable measure that may contribute to minimize changes of sodium perception [23]. Public health policies to reduce the intake of sodium could include a blend of these measures, together with public campaigns aiming to increase the awareness of the population on healthy eating.

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8. GENERAL DISCUSSION AND CONCLUSIONS

The results from this thesis show the gradual acquisition of western lifestyles by the adult population of Mozambique, further supporting the need for monitoring these exposures and their health impact at a population level, along with local specific patterns that may justify the relevance of tailored interventions in the Mozambican setting.

Excessive alcohol consumption, tobacco use and low fruit and vegetables intake are frequent risk factors in Mozambique while insufficient physical activity is very uncommon. On the other hand, traditional lifestyle behaviors namely the use of hand-rolled cigarettes and smokeless tobacco, the consumption of unprocessed/minimally processed foods and traditional dishes, and the high levels of work and transport physical activity, seem still well rooted among adult Mozambicans, though the process of acquisition of westernized behaviors is under way. Manufactured cigarettes and ultra-processed and processed food products, such as sugar sweetened beverages and chicken powdered stocks, are examples of goods that reflect the shift in behaviors, which do not occur simultaneously across population groups. The aggregation of risk factors also illustrates the socio-demographic gradient of the transition. Urban areas take the forward position, and generally, men and younger dwellers tend to move ahead of women and the older subjects. We may speculate however that the pattern of variation with age is more evident among men probably because of the higher social status of elderly women in Mozambique, compared to the younger, and particularly in the matriarchal families in the North of the country.

Insufficient physical activity does not yet seem of concern in Mozambique, although the ongoing economic development along with the improvements in technology, are expected to reduce both work and transport activity. This fact together with the very small contribution of recreation activities to the overall physical expenditure should call our attention to the possible evolution towards a more sedentary lifestyle. Recreational infrastructures are becoming increasingly scarce in Mozambican cities due to the urbanization which occupies the former leisure and sport areas for the construction of new buildings. It is thus important to anticipate this undesirable evolution by preparing the increasingly “urbanized” environment in order to favor active leisure activities. Public gardens, sports facilities and other recreational infrastructures, are examples of environmental factors that may encourage a more active leisure time.

Regarding tobacco use, the heterogeneity of patterns observed in Mozambican adults, predicts the potential for a shift from traditional forms of tobacco use to manufactured cigarette smoking, suggesting that the burden of tobacco-related diseases will increase. A

study with Mozambican migrants showed that women from the northern region and living at Maputo city are more frequent users of any form of tobacco in general and manufactured cigarettes in particular, than their counterparts, both from the host and origin region. In turn, men living at Maputo city virtually do not use traditional forms of tobacco, despite of being from regions where those forms of tobacco use were very rooted, suggesting that, at least some of them, have shifted to manufactured cigarettes smoking [100].

The pattern of alcohol drinking in Mozambique, characterized by a high frequency of heavy drinking episodes, facilitates the occurrence of injuries and NCD with already public health importance in Mozambique such as road traffic accidents and CV diseases [21]. Although in this study we have not addressed the type of alcoholic beverages consumed, in a previous report we documented the predominance of traditional beverages prepared at home, although coexisting with the consumption of commercial alcoholic beverages, particularly beer [101]. It is interesting to draw a parallel between tobacco and alcohol consumption patterns in this setting, given the similarity regarding the coexistence of traditional and modern practices in both of these addictive behaviors. As discussed for tobacco, it is also expected for alcohol, a shift from the traditional practices of preparing and sharing home-made fermented alcoholic beverages, towards a more "available" industrialized pattern of consumption, in a more urbanized context.

Alcohol- and tobacco-related diseases and conditions, are though expected to increase along with urbanization, economic purchase power growth and market expansion since those socio-economic determinants promote an increase in the availability and consumption of alcoholic beverages and tobacco [85]. The monitoring of their exposure and impact is therefore a major challenge in this setting, being crucial the implementation of targeted prevention and control strategies that take into account the coexistence of a diversity of consumption patterns. In order to develop such customized interventions, it would be useful to scrutinize the characterization of the use of tobacco and alcohol, namely to quantify the alcohol content in homemade alcoholic beverages, albeit roughly by their nature, and the tobacco effectively consumed in the case of hand-rolled cigarettes or smokeless tobacco. The characterization of the cultural contexts of consumptions is another aspect that would be useful to predict trends and to estimate the public health impact of those behaviors. Tobacco consumption and marketing has been regulated in Mozambique in 2007, whereas for alcohol no such population measures were yet adopted probably due to its higher cultural acceptance.

The very low prevalence of accomplishment of fruit and vegetables intake recommendations in a country where animal origin foods are scarcely consumed was, on a

first view, a quite surprisingly result. However, it is more easily understandable in light of the position of Mozambique regarding the nutrition transition model proposed by Popkin [28]. This author has described the nutrition transition encompassing five patterns which reflect a course of five stages (*Collecting food; Famine; Receding famine; Degenerative disease; and Behavioral change*). According to this classification, Mozambique seems to fit in the transition of the *Famine* pattern (stage 2) to the *Receding Famine* pattern (stage 3). Stage 2 is characterized by a low varied cereals based diet, along with high prevalence of nutritional deficiencies, besides a number of demographic characteristics (*e.g.* predominance of rural population, high fertility rate, short life expectancy, high infant and maternal mortality), whereas stage 3 is characterized by the continuity of a low varied diet, but an increase of animal protein, fruit and vegetables, along with a decrease in starchy staples, extinction of many nutritional deficiencies, along with shifts in demography (*e.g*. steep increase in urbanization, slow decrease in mortality and fertility, increase in life expectancy). Although in this thesis we had not addressed many aspects needed to characterize adequately the position of Mozambique according to this model, namely the nutritional intake, neither the overall food consumption in rural settings, our results from studies II and VII, particularly the positive relation of fruit intake with education in urban areas, and an already quite varied diet including the consumption of reasonable amounts of animal sources protein in Maputo city, suggest the existence of a delay in the nutritional transition in rural, compared to urban areas [28].

In this thesis we have included the four lifestyle factors evaluated according to STEPS methodology, but we felt the need to look further for other aspects that may contribute to explain the high prevalence of hypertension in this population, higher than any of the other main underlying physiologic/metabolic risk factors [87, 88, 102, 103].

Amongst the dietary factors associated with hypertension, sodium intake emerges as one of the strongest determinants, in addition to overweight and excessive alcohol consumption. Furthermore, the effects of sodium reduction on BP tend to be greater in blacks, middle-aged and older persons, and individuals with hypertension, which would be of great importance in Mozambique given the high proportion of hypertensive not controlled [104]. Since June 2013, a new STEPS optional module on dietary salt was made available by the WHO. This module contains six questions regarding the frequency of adding salt or salty seasonings when eating/preparing food, the perceptions on the amount of salt consumed and the relation between dietary salt and health. Despite not being available that specific module when STEPS was carried out in Mozambique, we went through exploring more broadly food habits in the

setting with particular attention to the practices regarding the consumption of salt/salty products. In fact, chicken powdered stocks, with high sodium content, were massively used by our sample of Maputo inhabitants and nearly all participants reported to add salt in food preparation.

Bread was quantitatively the most important contributor to the consumption of processed foods in our sample of Maputo dwellers, being reported by 80% of the participants. Despite the wide range of values observed, most of the samples of bread available in Maputo city were above the maximum levels (380 mg/100g), recommended in the neighbouring South Africa [105]. Taking into account that the median intake of bread reported by our sample of Maputo inhabitants was 150 g, bread contributed with nearly one third of the upper limit of the 2000 mg recommended by the WHO, in line with the observed in some regions of South Africa. In the latter country, the salt added to food at the table and in cooking and the sodium from processed foods are the main sources of this nutrient, being bread the single greatest contributor to intake (25% to 41%) amongst the fraction of sodium non-added to food at the table and in cooking [106]. Although, to the best of our knowledge, there is still no information on sodium intake or on the sources of sodium in the Mozambican population, we speculate that the sodium from salt/ chicken powdered stocks added to food preparations is high, given their large use by the studied population. Despite the still limited knowledge on patters of dietary exposure to salt in Mozambique, efforts to reduce sodium intake may benefit from measures to regulate the sodium content in processed foods, along with campaigns to rise the population awareness on healthy eating, anticipating an expected shift towards a more "industrialized" food pattern. Studying in depth dietary intake in Mozambique would be a very important step to accurately characterize food habits, both in urban and rural areas across the country, in order to monitor dietary adequacy over time and to anticipate undesirable changes.

Preliminary data on nutritional intake of a broader sample of dwellers from Maputo city (data not published), showed that 63% of the subjects did not meet the recommendations for potassium intake, another key nutrient, inversely associated with BP, and whose relation with sodium intake should be taken into account. In fact, highly processed, cheap foods, increasingly more accessible in low income nations with increasing urbanization and globalization, tend to be high in sodium and low in potassium. In contrast, the consumption of vegetables and fruit, rich in potassium, tends to decrease with urbanization, as reflected in the lower consumption of those foods in urban than in rural areas in Mozambique [107].

To understand how adult nutritional status is changing and how is influenced by the process of globalization, data on the tracking of the evolution of anthropometric parameters from childhood to adulthood are needed. Although child underweight persists in many parts of the developing world, adult obesity appears to precede child obesity [28]. When focusing specifically in prevalences of overweight in young women it is possible to observe that they are already higher than those of underweight women, especially in countries at higher levels of socio-economic development [108]. In Mozambique a similar pattern was described but only among urban dwellers [87], reflecting the nutrition transition shifts.

The clustering of NCD risk factors in Mozambique, dominated by hypertension and overweight, may also reflect the acquisition of new dietary habits. Among men, no "healthier" pattern was observed illustrating the leading acquisition of "modern" lifestyle behaviors by men in this setting. On the other hand, the predominance of the unhealthier patterns among older women reinforces their social status in the Mozambican society, translated into the higher prevalence of risky behaviors to health, even if socially undesirable. We must point out, however, that both tobacco and alcohol use may encompass traditional and modern forms of consumption of those addictive substances being not possible to distinguish them in this context. Nevertheless, the clustering of risk factors highlights the opportunity of implementing integrated approaches addressing multiple behaviors.

Early life determinants, such as maternal and childhood under-nutrition should not be disregarded since they lead to adaptive changes in growth and development that increases the susceptibility to NCD later in life [109]. These findings have particular relevance in developing countries, where the combination of poor nutrition in utero and a tendency to over nutrition in later life facilitates the occurrence of NCD [110]. This situation emphasizes the need of including non-adult populations in future surveys and starting early in life the prevention of NCD. The importance of prenatal and early life exposures to the later development of obesity suggests that efforts to prevent obesity should be included in maternal and child health, and nutrition programs [111].

In its draft action plan for the prevention and control of NCD 2013-2020 [112], the WHO established a set of voluntary global targets to be achieved in 2025 aiming at reducing by 25% in overall mortality from CV diseases, cancer, chronic respiratory diseases, and diabetes. Besides the reduction/control in lifestyle and physiologic risk factors, the WHO also proposed a goal regarding drug therapy to prevent myocardial infarction and stroke, of at least half of the eligible people receiving drug therapy and counselling. In this thesis, we also contributed to

better define the population to be targeted to pharmacological treatment for hypertension, which is certainly a crucial finding in the context of scarce resources of Mozambique where a very low proportion of hypertensive is controlled.

It is known that the achievement of the global goal for prevention and control of NCD would avoid a high number of deaths and would have major economic benefits [113]. However, to be successful, development efforts must include all diseases that put families in cycles of illness and poverty, regardless of their cause. Therefore, meeting basic needs such as housing, safe water and sanitation, employment, access to education and to health care in a supportive environment should be a priority.

The main conclusions of this thesis are the following:

- Excessive alcohol consumption, tobacco use and low fruit and vegetables intake are frequent risk factors in the adult Mozambican population, while insufficient physical activity is very uncommon.
- In Mozambique, western lifestyle behaviors coexist with traditional practices, reflected by the use of manufactured cigarettes (despite the very low number of cigarettes daily smoked), and processed food products, such as sugar sweetened beverages and chicken powdered stocks, concomitantly with the use of hand-rolled cigarettes and smokeless tobacco, the consumption of traditional dishes and patterns of drinking and sharing alcoholic beverages, and the high levels of work and transport physical activity.
- The analysis of sex-, age- and region-specific data suggests a socio-demographic gradient of the transition of NCD risk factors: urban areas take the forward position and, generally, male and younger dwellers tend to move ahead of female and older subjects.
- Hypertension, overweight/obesity, smoking and excessive alcohol intake defined the main clusters of CV risk factors. These results suggests the need to implement an integrated approach addressing multiple risk factors, in order to control the expected shift towards a more westernized lifestyle in Mozambique.

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